Background Material for Session at the June 14-15, 2004 Meeting of the SAB's Committee on Valuing the Protection of Ecological Systems and Services

Session entitled: Science Issues Related to a Retrospective Look at Recent History of Ecological Benefit Analysis at EPA for Significant Rules

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Purpose and Overview of this Document

Purpose

The purpose of this document is to provide Committee Members an overview of recent significant EPA regulatory activity so they would understand the breadth of EPA rulemakings, the requirements for benefit analysis, the kinds of rules for which ecological effects or ecological benefits were described, and the kinds of benefit assessments conducted.

The document is intended as background for the session at the June 2004 Committee Meeting entitled "Science Issues Related to a Retrospective Look at Recent History of Ecological Benefit Analysis at EPA for Economically Significant Rules Questions for this Session." This document and committee discussion at that session will provide context for the Committee "Example Exercise" for the discussion of the Confined Animal Feeding Operation Benefit analysis. The discussion will also provide identify initial conclusions regarding the committee's charge, as it pertains to Agency needs relating to *benefit analyses supporting regulations*.

Questions for the June 14th session include:

1. What kinds of ecological values were identified, characterized, and measured in EPA rules in the recent past? What kinds of values might be missing?
2. How were ecological values were identified, characterized, and measured in these rules?
3. How would discussion/assessment of these values compare with discussions/assessments used elsewhere for comparable purposes?
4. Are there suggestions for improving the use of data, approaches and methods in the short term?
5. Looking at these rules as a whole, are there recommendations for research?

Overview of this document

1. Recent rulemakings were sampled by identifying "Significant Regulatory Actions as Defined in the Agency's Regulatory Agenda." This list of final rules over the period 1996-2003, provided by EPA's Regulatory Management Division, were incorporated into Table 1. The list identifies all the major regulatory actions that EPA believed would meet the criteria of an "economically significant rule." Under Executive Order 12866 (Attachment A), EPA must determine whether a regulatory action is ``significant" and, therefore, subject to OMB review and the requirements of the Executive Order. The Order defines ``significant" regulatory action as one that i may:

    1. have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy,

productivity, competition, jobs, the environment, public health or safety in State, local, or tribal governments or communities;

2. create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;
3. materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or
4 raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order.

The rules in Table 1 provide only a small sample of the 500-600 regulatory actions EPA undertakes annually. Of those, only 150-200 are substantive (as opposed to procedural). Of that subset, only approximately 5-10 significant rules are finalized.

The rules cover a period in which the Office of Management and Budget (OMB) has reviewed all Agency's, including EPA's, economically significant rules. Over the period 1997-2004, *OMB has published a Report to Congress on the Costs and Benefits of Federal Regulations.*

Table 1 lists the final rules identified in advance as likely to be significant in the agency's regulatory agenda. The table also indicates if the rule noted ecological benefits, if the annual OMB Report to Congress discussed those benefits and if the rulemaking "Supplementary Text" discussed ecological benefits. For this purpose, "ecological effects" are defined broadly and include non-human environmental benefits, including visibility.

Following Table 1, this document provides two extracts from economic analyses/Regulatory Impact Analyses (RIA) illustrative of issues associated with benefits assessment of rules with ecological effects. The first example is an extract from the RIA Supporting the "Finding of Significant Contribution and Rulemaking for Certain States in the Ozone Transport Assessment Group Region for Purposes of Reducing Regional Transport of Ozone." The second example is an extract from the economics analysis Supporting the "Effluent Limitations Guidelines and New Source Performance Standards for the Construction and Development Category."

The Document then provides information to give a broader context for the issue of the need to improve benefit characterization supporting rulemakings concerned with Ecological Effects.

Appendix A provides a breakout by year, for the significant rules in Table 1 identified as having ecological effects, the the title, citation, and FEDERAL REGISTER "Summary" of the rule, as they appear in the FEDERAL REGISTER. It also provides extracts of the "Supplementary Text" that discusses "Ecological" and "Ecosystem" issues.

Appendix B contains the text of Executive Order 12866 on Regulatory Planning And Review; issued in 1993, which provides the definition and requirements for significant regulatory action.

Appendix C contains the text of OMB Circular A-4 Regulatory Analysis, issued September 17, 2003, which provides specific guidelines on characterizing ecological benefits for EPA to follow.

Appendix D contains the the Powerpoint Presentation made by Dr. Albert McGartland at the October 2003 Meeting of the Committee on "Valuing the Protection of Ecological Systems and Services. The presentation is entitled: Economics at the Environmental Protection Agency." The presentation contains background information on: Analysis Allowable Under Environmental Statutes; high points of Executive Order 12866 (as amended by Executive Order 13258); EPA's Rule Development Process; Components of an Economic Analysis; Benefit categories as described in EPA 2000. Guidelines for Preparing Economic Analyses. Washington, D.C.: Office of the Administrator. EPA 240-R-00-003; and some general slides on benefit-cost analysis)

TABLE 1 - SIGNIFICANT FINAL RULES AS IDENTIFIED IN THE AGENCY'S REGULATORY AGENDA

Year of Rule	Discussed in OMB Annual Report?	Rule Noted Eco Benefits?		Final FR Pub Date	FR Cite
1996					
		Yes	Acid Rain Program: Nitrogen Oxides Control Regulation	Final Action, 12/19/1996	61 FR 67112
		No	Control of Emissions of Air Pollution: Emission Standards for Gasoline Spark-Ignition and Diesel Compression-Ignition Marine Engines	Final Action, 10/04/1996	61 FR 52087
		No	Federal Test Procedure for Emissions From Motor Vehicles and Motor Vehicle Engines; Review	Final Action, 10/22/1996	61 FR 54852
		Yes	Land Disposal Restrictions - Phase III: Decharacterized Wastewaters, Carbamate Wastes, and Spent Aluminum Potliners	Final Action, 04/08/1996	61 FR 15566
		No	NSPS: Municipal Solid Waste Landfills Amendments	Final Action, 03/12/1996	61 FR 9905
		Yes	Regulation of Fuel and Fuel Additives: Certification Requirements for Deposit Control Additives	Final Action, 07/05/1996	61 FR 35310
		No	Risk Management Program for Chemical Accidental Release Prevention	Final Action, 06/20/1996	61 FR 31668

Year of Rule	Discussed in OMB Annual Report?	Rule Noted Eco Benefits?		Final FR Pub Date	FR Cite
1997					
		No	Compliance Assurance Monitoring Rule (Previously Enhanced Monitoring Rule)		
				Final Action, 10/22/1997	62 FR 54900
		Yes	Control of Emissions of Air Pollution From Nonroad Diesel Engines		
				Final 1, 10/21/1997	62 FR 54694
	Yes	Yes	Hospital/Medical/Infectious Waste Incinerators		
				Final Action, 09/15/1997	62 FR 48348
		Yes	Land Disposal Restrictions - Phase IV: Treatment Standards for Metal Wastes and Mineral Processing wastes; Mineral Processing Secondary Materials and Bevill Exclusion Issues		
				Final Rule, 05/12/1997	62 FR 25998
		Yes	NAAQS:Ozone		
				Final Action, 07/18/1997	62 FR 38856
		Yes	NAAQS: Particulate Matter		
				Final Action, 07/18/1997	62 FR 38652
		No	Regulation of Fuels and Fuel Additives: Interim Requirements for Deposit Control Gasoline Additives		
				Direct Final Action, 03/17/1997	62 FR 12572
				Final Action, 03/17/1997	62 FR 12564
		No	Transportation Conformity Rule Amendments: Flexibility and Streamlining		
				Final Action, 08/15/1997	62 FR 43780

Year of Rule	Discussed in OMB Annual Report?	Rule Noted Eco Benefits?		Final FR Pub Date	FR Cite
		No	Voluntary Standards for Light-Duty Vehicles		
				Final Original, 06/06/1997	62 FR 31192
1998					
		Yes	Control of Emissions from Nonroad Diesel Engines		
				Final Action, 10/23/1998	63 FR 56968
		Yes	Finding of Significant Contribution and Rulemaking for Certain States in the Ozone Transport Assessment Group (OTAG) Region for Purposes of Reducing Regional Transport of Ozone		
				Final Action, 10/27/1998	63 FR 57355
	Yes	Yes	Integrated NESHAP and Effluent Guidelines: Pulp and Paper		
				Final Action, 04/15/1998	63 FR 18504
		Yes	Land Disposal Restrictions - Phase IV: Treatment Standards for Metal Wastes and Mineral Processing wastes; Mineral Processing Secondary Materials and Bevill Exclusion Issue		
				Final 2, 08/31/1998	63 FR 46332
				Final Action, 05/26/1998	63 FR 28556
		Yes	Locomotive Emission Standards		
				Final Action, 04/16/1998	63 FR 18977
		No	National Primary Drinking Water Regulations: Interim Enhanced Surface Water Treatment Rule		
				Final Action, 12/16/1998	63 FR 69477
		No	National Primary Drinking Water Regulations: Stage I Disinfectant/Disinfection By-Products Rule		

Year of Rule	Discussed in OMB Annual Report?	Rule Noted Eco Benefits?		Final FR Pub Date	FR Cite
				Final Action, 12/16/1998	63 FR 69389
		Yes	NESHAP: Source Categories: (SOCMI) and and Other Processes Subject to the Negotiated Regulation for Equipment Leaks		
				Final: Correction, 12/09/1998	63 FR 67787
		No	NSPS: Municipal Solid Waste Landfills Amendments		
				Direct Final Action, 06/16/1998	63 FR 32743
		No	NSPS: Nitrogen Oxide Emissions From Fossil-Fuel Fired Steam Generating Units--Revision		
				Final Original, 09/16/1998	63 FR 49442
		No	PCBs; Polychlorinated Biphenyls (PCBs) Disposal Amendments		
				Final Action, 06/29/1998	63 FR 35384
		No	Voluntary Standards for Light-Duty Vehicles (National 49 State Low-Emission Vehicles Program)		
				Final Action, 03/09/1998	63 FR 11374
1999					
		Yes	Nonroad Spark-Ignition Engines At or Below 19 Kilowatts (25 Horsepower) (Phase 2)		
				Final, 03/30/1999	64 FR 15208
	Yes	Yes	NPDES Comprehensive Storm Water Phase II Regulations		
				Final Action, 12/08/1999	64 FR 68722
		No	Protection of Stratospheric Ozone: Allocation of 1999 Essential Use Allowances		
				Final Action, 01/07/1999	64 FR 1091

Year of Rule	Discussed in OMB Annual Report?	Rule Noted Eco Benefits?		Final FR Pub Date	FR Cite
		Yes	TRI; Reporting Threshold Amendment for Certain Persistent and Bioaccumulative Toxic Chemicals (PBTs)	Final Action, 10/29/1999	64 FR 58666
2000					
		No	Control of Emissions of Air Pollution From 2004 and Later Model Year Heavy-Duty Highway Engines and Vehicles; Revision of Light-Duty Truck Definition	Final Action, 10/06/2000	65 FR 59895
		Yes	Nonroad Spark-Ignition Engines At or Below 19 Kilowatts (25 Horsepower) (Phase 2)	Final Handheld, 04/25/2000	65 FR 24267
		No	Protection of Stratospheric Ozone: Incorporation of Clean Air Act Amendments for Reduction in Class I, Group VI Controlled Substances	Direct Final Action, 11/28/2000	65 FR 70795
		No	Tier II Light-Duty Vehicle and Light-Duty Truck Emission Standards and Gasoline Sulfur Standards	Final Action, 02/10/2000	65 FR 6698
2001					
		Yes	Heavy-Duty Engine Emission Standards & Diesel Fuel Sulfur Control Requirements	Final Action, 01/18/2001	66 FR 5002
		No	Lead; Identification of Dangerous Levels of Lead Pursuant to TSCA Section 403	Final Action, 01/05/2001	66 FR 1206

Year of Rule	Discussed in OMB Annual Report?	Rule Noted Eco Benefits?		Final FR Pub Date	FR Cite
		Yes	NESHAP: Chemical Recovery Combustion Sources at Kraft, Soda, Sulfite and Stand-Alone Semichemical Pulp Mil	Final Action, 01/12/2001	66 FR 3180
2002					
		Yes	Emissions from Nonroad Spark-Ignition Engines and Standards for Recreational Spark-Ignition Engines	Final Action, 11/08/2002	67 FR 68242
2003					
	Yes	Yes	National Pollutant Discharge Elimination System Permit Regulation and Effluent Guidelines and Standards for Concentrated Animal Feeding Operations (CAFOs)	Final Action, 02/12/2003	68 FR 7176

Extracts from Economic Analyses/Regulatory Impact Analyses (RIA) Illustrating How Ecological Effects Have Been Characterized

Extract from the RIA Supporting the "Finding of Significant Contribution and Rulemaking for Certain States in the Ozone Transport Assessment Group Region for Purposes of Reducing Regional Transport of Ozone." (Commonly called the NOx SIP Call).

A Summary of the rule and extracts of supplementary information related to it can be found in Appendix A as a 1998 significant final rule.

Links to the full text of the RIA supporting the NOx SIP Call can be found at: http://www.epa.gov/ttn/ecas/ria.html

Chapter 4 of the RIA discusses the "Benefits of Regional NOX Reductions." Section 4.1, "Overview of Benefits Estimation," Section 4.4, "Ozone- and PM-related Welfare Effects," Section 4.5, "Total Benefits," Section 4.6., "Limitations of the Analysis," and Section 4.7., "References" are inserted below.

4.1 Overview of Benefits Estimation

Most of the specific methods and information used in this benefit analysis are similar to those used in the §812 Retrospective of the Benefits and Costs of the Clean Air Act and forthcoming §812 Prospective EPA Reports to Congress, which were reviewed by EPA's Science Advisory Board (EPA, 1997c),as well as the approach used by EPA in support of revising the ozone and PM NAAQS in 1997 (EPA, 1997a and 1997b).

Prior to describing the details of the approach for the benefits analysis, it is useful to provide an overview of the approach. The overview is intended to help the reader better identify the role of each issue described later in this chapter.

The general term "benefits" refers to any and all outcomes of the regulation that are considered positive; that is, that contribute to an enhanced level of social welfare. The economist's meaning of "benefits" refers to the dollar value associated with all the expected positive impacts of the regulation; that is, all regulatory outcomes that lead to higher social welfare. If the benefits are associated with market goods and services, the monetary value of the benefits is approximated by the sum of the predicted changes in "consumer (and producer) surplus." These "surplus" measures are standard and widely accepted measures in the field of applied welfare economics, and reflect the degree of well being enjoyed by people given different levels of goods and prices. If the benefits are non-market benefits (such as the risk reductions associated with environmental quality improvements), however, other methods of measuring benefits must be used. In contrast to market goods, non-market goods such as environmental quality improvements are public goods, whose benefits are shared by many people. The total value of such a good is the sum of the dollar amounts that all those who benefit are willing to pay.

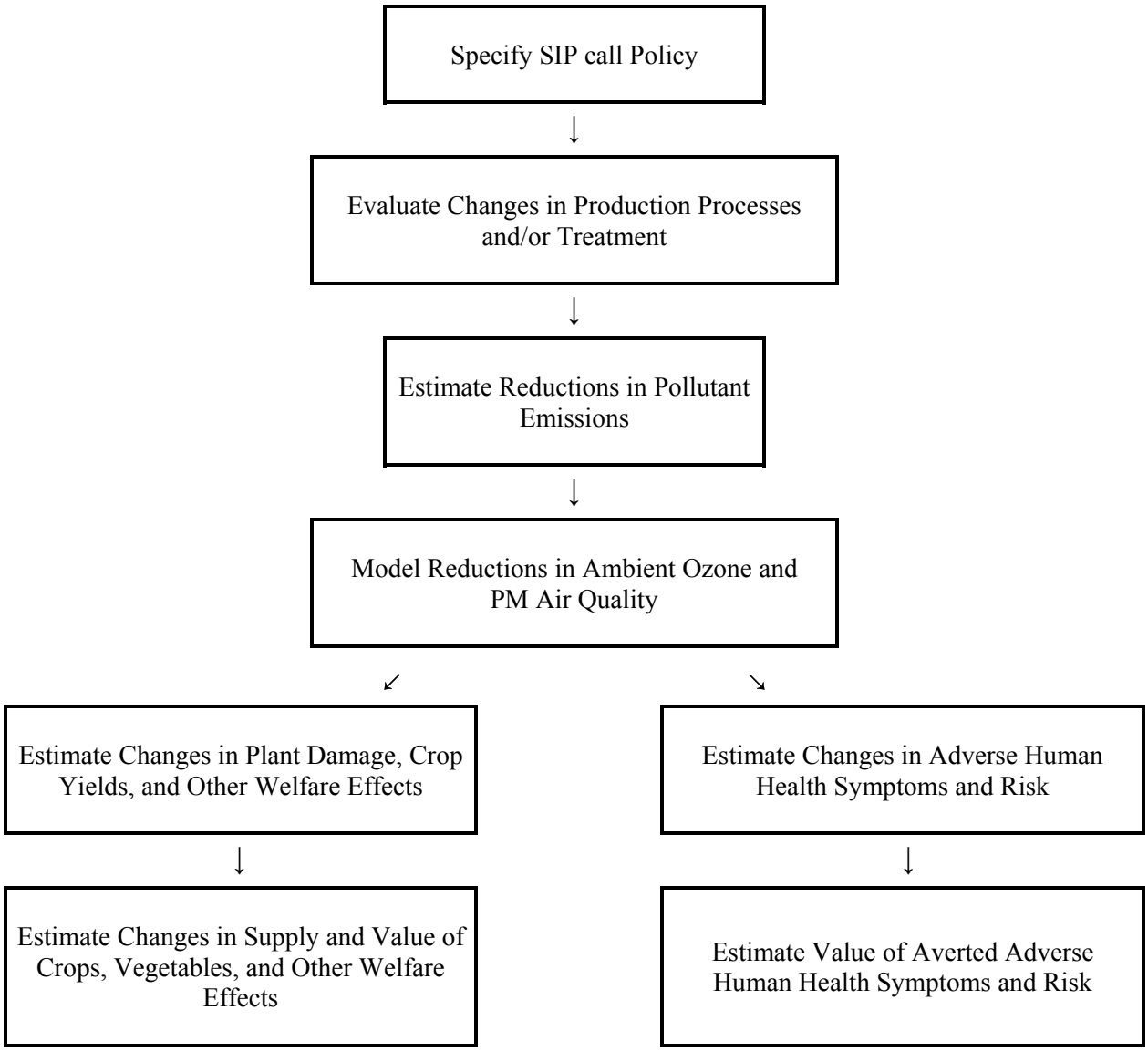
In addition to benefits, regulatory actions may also lead to potential disbenefits, i.e. outcomes that have a negative impact on social welfare. In general these disbenefits will be incidental to the stated goals of the regulation, otherwise (in an efficient regulatory environment) the regulation would not have been promulgated. In order to fully quantify the benefits and costs of a regulatory action, both the benefits and disbenefits should be calculated, so that net benefits (equal to benefits minus disbenefits minus costs) will not be biased upwards. In many cases, however, disbenefits are difficult to quantify, as it is often unclear where and how disbenefits will occur. Benefits may also be difficult to quantify, since many benefits are not measurable using market based measures.

This conceptual economic foundation raises several relevant issues and potential limitations for the benefits analysis of the regulation. First, the standard economic approach to estimating environmental benefits is anthropocentric -- all benefits values arise from how environmental changes are perceived and valued by people in present-day values. Thus, all near-term as well as temporally distant future physical outcomes associated with reduced pollutant loadings need to be predicted and then translated into the framework of present-day human activities and concerns. Second, as noted below, it is not possible to quantify or to value all of the benefits resulting from environmental quality improvements.

Conducting a benefits analysis for anticipated changes in air emissions is a challenging exercise. Assessing the benefits of a regulatory action requires a chain of events to be specified and understood. As shown in Figure 4-1, illustrating the causality for air quality related benefits, the estimation of benefits requires information about: (1) institutional relationships and policy-making; (2) the technical feasibility of pollution abatement; (3) the physical-chemical properties of air pollutants and their consequent linkages to biological or ecological responses in the environment, and (4) human responses and values associated with these changes.

The first two steps of Figure 4-1 reflect the institutional and technical aspects of implementing the NOx SIP call regulation (the improved process changes or pollutant abatement). The estimated changes in ambient PM or ozone concentrations are directly linked to the estimated changes in precursor pollutant emission reductions through the use of air quality modeling, as described in Chapter 10.

Figure 4-1 Example Methodology of a Benefits Analysis



A "damage function" approach is used to estimate the adverse physical effects from air pollution that will be avoided in the eastern United States due to implementation of the emission reductions required by the NOx SIP call (the exception to this is the estimation of nitrogen deposition benefits, which uses an avoided cost approach). An "economic unit value" approach is used (for most effect categories, e.g., premature mortality or chronic bronchitis) to estimate society's aggregate demand (i.e., willingness to pay) for avoiding each type of physical effect on a per incidence level. Total value for a given physical effect is simply the product of the number of incidences avoided and the value per incidence avoided. All dollar estimates of monetary benefits presented in this chapter are in 1990 dollars.

The valuation of avoided incidences of health effects and avoided degradation of welfare effects relies on benefits transfer. The benefits transfer approach takes values or value functions generated by previous research and transfers them from the study to the policy of interest. For example, the value of reduced mortality is obtained from a distribution of values of statistical life based on 26 wage-risk and contingent valuation studies. None of the values for the health and welfare categories valued in this benefit analysis were generated specifically in the context of the NOx SIP call.

The first step in a benefits analysis using this approach is the identification of the types or categories of benefits associated with the anticipated changes in ambient air quality conditions. The second step is the identification of relevant studies examining the relationships between air quality and these benefit categories and studies estimating the value of avoiding damages. Table 4-1 provides an example of the types of benefits potentially observed as a result of changes in air quality. The types of benefits identified in both the health and welfare categories can generally be classified as use benefits or non-use benefits.

Use benefits are the values associated with an individual's desire to avoid exposure to an environmental risk. Use benefits include both direct and indirect uses of affected ambient air, and embrace both consumptive and non-consumptive activities. In most applications to air pollution scenarios, the most prominent use benefits are those related to human health risk reductions, effects on crops and plant life, visibility, and materials damage.

Non-use (intrinsic) benefits are values an individual may have for lowering air pollution concentrations or the level of risk unrelated to his or her own exposure. Individuals apart from any past, present, or anticipated future use of the resource in question can value improved environmental quality. Such non-use values may comprise a significant portion of the total monetary benefits. However, the dollar amount to assign to these non-use values often is a matter of considerable debate. While human uses of a resource can be observed directly and valued with a range of technical economic techniques, non-use values must be ascertained through indirect methods, such as asking survey respondents to reveal their values.

Table 4-1
Examples of Potential Benefits of Air Quality Improvements

USE BENEFITS	EXAMPLES
Direct	Human Health Improvements (e.g., less incidences of coughing) Increased Crop Yields
Indirect	Non-Consumptive Use (e.g., improved visibility for recreational activities)
Option Value	Risk Premium for Uncertain Future Demand Risk Premium for Uncertain Future Supply (e.g., treating as insurance, the protection of a forest just in case a new use for a forest product will be discovered in the future)
Aesthetic	Residing, working, traveling, and/or owning property in reduced smog locations
NON-USE BENEFITS	
Bequest	Intergenerational Equity (e.g., an older generation wanting a younger generation to inherit a protected environment)
Existence	Stewardship/Preservation/Altruistic Values (e.g., individuals wanting to protect a forest even if they know that they will never use the forest) Ecological Benefits

Non-use values may be related to the desire that a clean environment be available for the use of others now and in the future, or may be related to the desire to know that the resource is being preserved for its own sake, regardless of human use. The component of non-use value that is related to the use of the resource by others in the future is referred to as the bequest value. This value is typically thought of as altruistic in nature. For example, the value that an individual places on reducing the general population's risk of PM and/or ozone exposure either now or in the future is referred to as the bequest value. Another potential component of non-use value is the value that is related to preservation of the resource for its own sake, even if there is no human use of the resource. This component of non-use value is sometimes referred to as existence value. An example of an existence value is the value placed on protecting the habitats of endangered species from the effects of air pollution, even if the species have no direct use to humans.

The majority of health and welfare benefits categories included in this analysis can be classified as direct use benefits. These benefits are discussed in greater detail than other benefits categories presented in Table 4-1 because more scientific and economic information has been gathered for the direct use benefits category. Detailed scientific and economic information is not as readily available for the remainder of the potential benefits categories listed in Table 4-1. Information pertaining to indirect use,

option value, aesthetic, bequest, and existence benefits is often more difficult to collect. For example, lowering ambient ozone concentrations in an area is expected to reduce physical damage to ornamental plants in the area. Homeowners living in the affected area with ornamental plants in their yards are expected to benefit from the reduced damage to their plants, with the plants possibly exhibiting an improved appearance or experiencing an extended life. Although scientific information can help identify the benefits category of decreased damage to urban ornamentals, lack of more detailed scientific and economic information (e.g., exposure-response relationships for urban ornamentals and values associated with specific types of injuries and mitigation) currently prevents quantification of this benefits category.

It is also difficult to identify all the types of benefits that might result from environmental regulation and to value those benefits that are identified. A cost analysis is expected to provide a more comprehensive estimate of the cost of an environmental regulation because technical information is available for identifying the technologies that would be necessary to achieve the desired pollution reduction. In addition, market or economic information is available for the many components of a cost analysis (e.g., energy prices, pollution control equipment, etc.). A similar situation typically does not exist for estimating the benefits of environmental regulation. This problem is due to the non-market nature of many benefits categories. Since many pollution effects (e.g., adverse health or ecological effects) traditionally have not been traded as market commodities, economists and analysts cannot look to changes in market prices and quantities to estimate the value of these effects. This lack of observable markets may lead to the omission of significant benefits categories from an environmental benefits analysis. Likewise, difficulties in measuring disbenefits may lead to a positive bias in net benefits. The net result of underestimating benefits and disbenefits will depend on how completely each category is measured.

Because of the inability to quantify many of the benefits categories listed in Table 4-1, as well as the omission of unknown but relevant environmental benefits categories, the quantified benefits presented in this report may underestimate total benefits. It is not possible to quantify the magnitude of this underestimation. The more important of these omitted effect categories are shown in Table 4-2. Underestimation of total benefits may be mitigated to some extent if there are also relevant disbenefit categories that are omitted or unquantified.

Within each effect category, there may be several possible estimates of health and welfare effects or monetary benefit values. Each of these possibilities represents a health or welfare "endpoint." The basic structure of the method used to conduct the benefits analysis is to create a set of benefit estimates reflecting different key assumptions concerning environmental conditions and the responsiveness of human health and the environment to changes in air quality. Total benefits are presented as a plausible range representing the sensitivity of benefits over the set of maintained assumptions. The upper and lower ends of the plausible range of total benefits are constructed using estimates of non-overlapping endpoints for each effect category, selected to avoid double counting. Double counting occurs when two endpoints contain values for the same thing. For example, an endpoint measuring avoided incidences of all hospital admissions would incorporate avoided incidences of hospital admissions just for heart disease. Thus including values for avoiding both types of hospital admissions would double count the value of avoided hospital admissions for heart disease. The upper and lower ends of the plausible range do not necessarily represent the sum of the highest values for each endpoint. Instead, they represent the points associated with the combinations of assumptions that are expected to generate the lowest and highest benefit estimates for the majority of regulatory alternatives. The plausible range does not provide information on the likelihood of any set of assumptions being the correct one. Thus, while the plausible

range indicates the sensitivity of benefits to the various assumptions, it requires a subjective determination of which assumption set most closely represents reality.

Table 4-2
Unquantified Benefit Categories*

	Unquantified Benefit Categories Associated with Ozone and Nitrogen Oxides	Unquantified Benefit Categories Associated with PM
Health Categories	Airway responsiveness Pulmonary inflammation Increased susceptibility to respiratory infection Acute inflammation and respiratory cell damage Chronic respiratory damage/Premature aging of lungs Ultraviolet-B radiation (disbenefit)	Changes in pulmonary function Morphological changes Altered host defense mechanisms Cancer Other chronic respiratory disease
Welfare Categories	Ecosystem and vegetation effects in Class I areas (e.g., national parks) Damage to urban ornamentals (e.g.,grass, flowers, shrubs, and trees in urban areas) Fruit and vegetable crops Reduced yields of tree seedlings, commercial and non-commercial forests Damage to ecosystems Materials damage (other than consumer cleaning cost savings) Nitrates in drinking water Brown Clouds	Materials damage (other than consumer cleaning cost savings) Damage to ecosystems (e.g., acid sulfate deposition) Nitrates in drinking water Brown Clouds

* Note that there are other pollutants that are reduced in conjunction with strategies implemented to reduce NOx emissions for the SIP call. These include carbon (a pollutant associated with global climate change) and mercury (a toxic pollutant). These emission reductions are also not considered in this benefits analysis.

There are many subjective judgements that must be made in order to select the set of relationships and values for the benefits analysis. The specific selections used to develop the plausible range are designed to reflect the EPA's best current judgement on each issue, considering the state of current scientific knowledge, previous Agency analyses, and the most recent advice provided by EPA's Science Advisory Board on performing benefits analysis for criteria air pollution control programs. There are, however, defensible alternatives to virtually every decision about the makeup of the plausible range. In order better to inform the reader of important alternative assumptions that could have been made, and to provide an understanding of the impact of each alternative on the overall assessment of the monetary

benefits, the benefits analysis includes a number of quantitative sensitivity analyses. Individual sensitivity analyses examine the effects of using alternative assumptions about individual choices incorporated in the benefits analysis, such as the impact of using short-term (daily) mortality functions instead of a long-term (chronic exposure) function.

Sensitivity analyses are also used to explore the impacts of including other endpoints, such as PM-related infant mortality, that are not as well understood as the effects included in the benefits analysis. Sensitivity analyses will also be used to explore the effects of alternative valuation approaches, such as the use of alternative agricultural market simulation models.

A very important component in estimating PM-related health and welfare benefits is the characterization of air quality changes. Several models developed in recent years are capable of estimating PM_{10} concentrations, but have not been rigorously tested for estimating ambient concentrations of $PM_{2.5}$ because there is currently sparse monitoring of the data necessary to benchmark model performance. As indicated in Chapter 3, two air quality models, RADM-RPM and the Source-Receptor (S-R) Matrix, are used in this analysis to predict changes in ambient PM levels given changes in NOx and SO_2 emissions. The defining characteristics of each of these models are laid out in Chapter 3. It is not clear which of these models will better predict the Eastern U.S. atmosphere in the 2007 policy year. In order to reflect this uncertainty, the plausible range for individual PM-related health and welfare endpoints will incorporate estimates of avoided incidences and monetary benefits generated under each modeling framework.

Because of the nonlinear chemistry used by RADM-RPM to predict changes in $PM_{2.5}$, estimates of avoided incidences and associated monetary benefits may not follow a predictable pattern across regulatory alternatives. Previous experience with PM air quality models would suggest that benefits will increase as controls become more stringent, however, these models lacked or used incomplete characterizations of the role of NOx emissions in the production of oxidant fields that convert SO2 to acid sulfates, leading to a simplified characterization of the interactions between acid sulfates, nitrates, and ammonium. The role of NOx emissions in photochemistry can introduce non-linearities which, given the right set of atmospheric conditions, can result in situations where decreases in NOx can lead to increases in PM in some regions[1]. This can lead to smaller benefits for a more stringent regulatory alternative relative to a less stringent regulatory alternative (Dennis, 1998). This seems to be occurring in the 0.15 trading alternative, especially in the Northwest, Upper Midwest and Upper New England regions of the OTAG domain. In addition, implementation of specific control strategies, such as shifting of power generation and emissions trading under the Acid Rain Trading program can result in increases in SO_2 emissions in states outside the NOx SIP call region. In the 0.15 and 0.12 trading alternatives, significant shifts in power generation seem to be occuring between SIP call states and Gulf Coast states, leading to increases in both NOx and SO_2 emissions along the Gulf Coast, relative to the analysis baseline. Increases in PM in the Northeast and northwestern regions of the SIP call region seem to be caused by a combination of atmospheric chemistry and emissions trading, as well as transport of pollutants, especially in Pennsylvania and the upper New England area.

[1] See Chapter 3 Sections 3.3 and 3.4 for a more detailed discussion of the air quality models. See Appendix E for a more thorough discussion of the affect of non-linear chemistry on particle formation.

Because the modeled distributions of PM concentrations are non-normally distributed, the ordering effect is dependent on whether health effects are calculated using the median versus mean $PM_{2.5}$ concentration. The non-linearities in the air-chemistry change with movement from the lower tail to the upper tail of the distribution of PM concentrations. Non-linearities are more pronounced at the 50^{th} percentile of the distribution than at the 90^{th} percentile (Dennis, 1998). This can result in a greater degree of non-linearity in benefits results that are dependent on the median versus the mean. Implications of this for the SIP call benefits analysis are that relative to other endpoints, estimates of PM-related long-term mortalities, which are based on median $PM_{2.5}$ concentrations, are more sensitive to the non-linear chemistry effects between alternatives.

Throughout this benefits analysis, sensitivity analyses for assumptions affecting only a single endpoint and with no expected directional effect will be presented directly following the plausible range. These sensitivity analyses include short-term PM-related mortality, PM-related neo-natal mortality, alternative agricultural models, and an analysis of the effect of using only ozone mortality studies with a significant ozone coefficient to generate avoided ozone mortality incidences.

Table 4-3 lists the specific health and welfare effects that are included in the benefits analysis, indicating the specific effect categories that are included in the plausible range of benefits, as well as effects that are presented (or explored in greater detail) as quantified sensitivity analyses. Also included in Table 4-3 are the estimates of mean Willingness to Pay (WTP), or "unit values" used to monetize the benefits for each endpoint.

Table 4-3
Quantified and Monetized Health and Welfare Effects

Endpoint	Pollutant	Mean WTP per incident ($1990)
Health Effects in the Benefits Analysis		
Mortality, Long-term Exposure - Over age 30	$PM_{2.5}$	$4,800,000
Mortality, Short-term Exposure	Ozone	$4,800,000
Chronic Bronchitis - All Ages	PM_{10}	$260,000
Hospital Admissions - All Respiratory, All Ages	Ozone & PM_{10}/$PM_{2.5}$	$6,712 (Ozone) $6,344 (PM)
Hospital Admissions - Congestive heart failure	PM_{10}	$8,280
Hospital Admissions - Ischemic heart disease	PM_{10}	$10,308
Any of 19 Acute Respiratory Symptoms -Adult	Ozone	$18
Acute Bronchitis - Children	PM_{10}/$PM_{2.5}$	$45
Lower Respiratory Symptoms - Children	PM_{10}	$12
Upper Respiratory Symptoms - Children	PM_{10}	$19
Work Loss Days - Adult	$PM_{2.5}$	$83
Minor Restricted Activity Days (MRAD) - Adult	$PM_{2.5}$	$38
Welfare Effects in the Benefits Analysis		
Agriculture - Select Commodity Crops	Ozone	Direct Valuation
Household Soiling	PM_{10}	$2.52/household/$\mu g/m^3$ change in PM_{10}
Nitrogen Deposition in Estuarine and Coastal Waters	NOx	$105/kg of nitrogen
Decreased Worker Productivity	Ozone	$1/worker/10% change in Ozone
Visibility - Residential	Light Extinction[a]	$14/household/deciview
Visibility - Select Class I areas	Light Extinction[a]	$4/household/deciview

Endpoints Presented as Sensitivity Analyses		
Mortality, Short-term Exp. -- Only significant studies	Ozone	$4,800,000
Mortality, Short-term Exp. - Over age 65	$PM_{2.5}$	$4,800,000
Post-Neonatal Mortality	PM_{10}	quantified but not monetized
Commercial Crops -- AGSIM model	NOx	$105/kg

[a] Measured in terms of deciview change.

4.4 Ozone- and PM-related Welfare Effects

In addition to the effects on human health described above, reducing NOx emissions in the eastern United States will also have welfare (i.e., non-health) effects. Welfare effects cover a potentially broad range of adverse effects, including adverse impacts on plants, animals, structural materials, visibility, and ecosystem functions. Like health effects, in order to be included in a quantified monetary benefits analysis, all of the analytical links between changes in emissions and the monetary value of the effects must be available. While the required analytical components are available for certain welfare endpoints, many other likely or possible welfare categories are omitted from the analysis. The availability of information on each analytical step limits the total coverage of the welfare effects. All of the welfare benefits that are quantified and included in the benefits analysis were included in the PM and ozone NAAQS RIA. However, there have been some changes in the quantification of certain welfare effects, which are described in this section. Table 4-20 lists the welfare categories that are included in the benefits analysis.

The welfare categories included in the SIP call analysis that use the identical procedures previously used are described in the technical support document for this RIA (Abt Associates, 1998a). The remainder of this section describes aspects of the welfare analysis that are different than the ozone and PM NAAQS RIA.

Table 4-20
Quantified Ozone- and PM- Related Welfare Effects
Included in the Benefits Analysis

Welfare Effect	Pollutant	Study
Agriculture - Commodity Crops	Ozone	Mathtech, 1998
Nitrogen Deposition in Estuarine and Coastal Waters	NOx	EPA, 1998
Decreased Worker Productivity	Ozone	Crocker and Horst, 1981 and EPA, 1994
Visibility-Class I Areas (SE only)	PM	Chestnut et al., 1997
Visibility-Residential	PM	McClelland et al., 1991
Household Soiling	PM	ESEERCO, 1994

4.4.1 Commodity Agricultural Crops

The economic value associated with varying levels of yield loss for ozone-sensitive commodity crops is analyzed using a revised and updated Regional Model Farm (RMF) agricultural benefits model (Mathtech, 1998a). The RMF is an agricultural benefits model for commodity crops that account for about 75 percent of all U.S. sales of agricultural crops. The RMF explicitly incorporates exposure-response functions into microeconomic models of agricultural producer behavior. The model uses the theory of applied welfare economics to value changes in ambient ozone concentrations brought about by particular policy actions such as the NOx SIP call.

The measure of benefits calculated by the model is the net change in consumers' and producers' surplus from baseline ozone concentrations to the ozone concentrations resulting from attainment of alternative standards. Using the baseline and post-control equilibria, the model calculates the change in net consumers' and producers' surplus on a crop-by-crop basis[3]. Dollar values are aggregated across crops for each standard. The total dollar value represents a measure of the change in social welfare associated with the regulatory alternative. Although the model calculates benefits under three alternative welfare measures (perfect competition, price supports, and modified agricultural policy), results presented here are based on the "perfect competition" measure to reflect recent changes in agricultural subsidy programs. Under the recently revised 1996 Farm Bill , most eligible farmers have enrolled in the program to phase out government crop price supports for the RMF-relevant crops: wheat, corn, sorghum, and cotton.

[3] Agricultural benefits differ from other health and welfare endpoints in the length of the assumed ozone season. For agriculture, the ozone season is assumed to extend from April to September. This assumption is made to ensure proper calculation of the ozone statistic used in the exposure-response functions. The only crop affected by changes in ozone during April is winter wheat.

For the purpose of this analysis, the six most economically significant crops are analyzed: corn, cotton, peanuts, sorghum, soybean, and winter wheat. In the 37-state region modeled in this analysis, these crops were valued at over $70 billion in 1997. The model employs biological exposure-response information derived from controlled experiments conducted by the National Crop Loss Assessment Network (NCLAN) (Lee et al., 1996). Four main areas of the RMF have been updated to reflect the 1996 Farm Bill and USDA data projections to 2005 (the year farthest into the future for which projections are available). These four areas are yield per acre, acres harvested, production costs, and model farms. Documentation outlining the 2005 update is provided in EPA, 1997a.

Table 4-21 presents estimates of monetary benefits due to changes in the production of all six commodity crops associated with five regulatory alternatives for the NOx SIP call. Estimates for both most and least ozone sensitive crops are presented in Table 4-21. The highest benefit estimate of $415 million (assuming relatively sensitive cultivars for the 0.12 Trading alternative) is a relatively small 0.6% of the total 1997 crop value. This suggests that individual farmers are not likely to identify ozone sensitivity as a major factor in observed yield changes in the presence of other more obvious factors, such as meterology, fertilization, and pest resistance. Likewise, given the relative importance of other yield enhancing crop traits, such as pest resistence, it is unlikely that seed developers will focus on development of ozone tolerant varieties. Nonetheless, to the extent that ozone resistant cultivars are available and farmers respond to increased ozone levels by subtituting towards more ozone resistant cultivars, crop losses will be reduced.

Table 4-21
Changes in Production of Commodity Crops and Monetary Benefits Associated with the NOx SIP Call

Regulatory Alternative	Monetary Benefits (millions 1990$)	
	Least Sensitive Cultivars	Most Sensitive Cultivars
0.12 Trading	$53	$415
0.15 Trading	$47	$361
Regionality 1	$43	$318
0.20 Trading	$42	$312
0.25 Trading	$34	$242

AGSIM is an alternative agricultural sector model which has gained popularity in the agricultural economics field. It has been extensively peer-reviewed and it estimates a more complete set of responses to yield changes than RMF. The primary difference is that AGSIM models planted acreage as a behavioral response to yield and relative price changes, while RMF treats planted acres as a fixed factor. As a sensitivity analysis, AGSIM was run for the five regulatory alternatives to determine how AGSIM

performs relative to RMF. RMF was chosen for the primary analysis because it has been extensively tested and used in previous regulatory impact analyses. For a complete description of AGSIM, see the AGSIM technical support document (Abt Associates, 1998b).

Table 4-22 presents AGSIM generated estimates of monetary benefits due to changes in the production of all six commodity crops associated with the five regulatory alternatives for the NOx SIP call. Estimates for both most and least ozone sensitive crops are presented in Table 4-22. As might be expected, differences between the results of the models are relatively small when the least sensitive cultivars are used, while differences are much larger when the most sensitive cultivars are used. Values for AGSIM exceed those from RMF by 40 to 44 percent, depending on the regulatory alternative.

Table 4-22
Sensitivity Analysis: AGSIM Generated Monetary Benefits Due to Changes in Production of Commodity Crops Associated with the NOx SIP Call

Regulatory Alternative	Monetary Benefits (millions 1990$)	
	Least Sensitive Cultivars	Most Sensitive Cultivars
0.12 Trading	$51	$595
0.15 Trading	$44	$521
Regionality 1	$38	$451
0.20 Trading	$37	$440
0.25 Trading	$29	$338

4.4.2 Commercial Forests

Any attempt to estimate economic benefits for commercial forests associated with reductions in ozone arising from implementation of the NOx SIP call is constrained by a lack of exposure-response functions for the commercially important mature trees. Although exposure-response functions have been developed for seedlings for a number of important tree species, these seedling functions cannot be extrapolated to mature trees based on current knowledge. Recognizing this limitation, a study (Pye, 1988 and deSteiger & Pye, 1990) involving expert judgment about the effect of ozone levels on percent growth change is used to develop estimates of ozone-related economic losses for commercial forest products.

An analysis by Mathtech in conjunction with the USDA Forest Service (Mathtech, 1998b) of forestry sector benefits quantifies the effect of ozone on tree growth and the demand and supply characteristics of the timber market. The estimates do not include possible non-market benefits such as aesthetic effects. Forest aesthetics is discussed qualitatively later in this chapter.

The economic value of yield changes for commercial forests was estimated using the 1993 timber assessment market model (TAMM). TAMM is a U.S. Forest Service (Adams and Haynes, 1996) spatial model of the solidwood and timber inventory elements of the U.S. forest products sector. The model provides projections of timber markets by geographic region and wood type through the year 2040. Nine regions covering the continental U.S. are included in the analysis. TAMM simulates the effects of reduced O_3 concentrations on timber markets by changing the annual growth rates of commercial forest growing-stock inventories. The model uses applied welfare economics to value changes in ambient O_3 concentrations. Specifically, TAMM calculates benefits as the net change in consumer and producer surplus from baseline O_3 concentrations to the O_3 concentrations resulting from implementation of the NOx SIP call policy.

Table 4-23 presents estimates of monetary benefits of yield changes of commercial forests associated with the five policy alternatives for the NOx SIP call. EPA did not estimate monetary benefits for all policy alternatives. Benefits for excluded alternatives can be easily estimated using a ratio of estimated benefits to a similar benefit category, such as commodity crops. Benefits for the 0.25 trading and Regionality 1 alternatives are estimated by applying the ratio of forestry to agricultural benefits for the 0.15 trading alternative, equal to 0.59, to the agricultural benefits for these two alternatives.

Because of the long harvesting cycle of commercial forests and the cumulative effects of higher growth rates, the benefits to the future economy will be much larger than the estimates reported in Table 4-23. For example, the 0.12 trading policy alternative would result in about $8.0 billion additional forest inventories by 2040. The estimated annualized benefits for this alternative, $233 million, are much lower because of smaller benefits in earlier years (i.e., the 2010 and 2020 decades) and because the higher benefits realized in later years are heavily discounted.

Table 4-23
Commercial Forest Monetary Benefits Associated with the NOx SIP Call

Regulatory Alternative	Monetary Benefits (millions 1990$)
0.12 Trading	$233
0.15 Trading	$213
Regionality 1	$188
0.20 Trading	$185
0.25 Trading	$143

4.4.3 Nitrogen Deposition

Excess nutrient loads, especially that of nitrogen, are responsible for a variety of adverse consequences to the health of estuarine and coastal waters. These effects include toxic and/or noxious

algal blooms such as brown and red tides, low (hypoxic) or zero (anoxic) concentrations of dissolved oxygen in bottom waters, the loss of submerged aquatic vegetation due to the light-filtering effect of thick algal mats, and fundamental shifts in phytoplankton community structure. Direct concentration-response functions relating deposited nitrogen and reductions in estuarine benefits are not available. The preferred willingness-to-pay based measure of benefits depends on the availability of these concentration-response functions and on estimates of the value of environmental responses. Because neither appropriate concentration-response functions nor sufficient information to estimate the marginal value of changes in water quality exist at present, an avoided cost approach is used instead of willingness-to-pay to generate estuary related benefits of the NOx SIP call.

The benefits to surrounding communities of reduced nitrogen loadings resulting from various control strategies for atmospheric NOx emissions are calculated for 10 East and 2 Gulf Coast case study estuaries, and extrapolated to all 43 Eastern U.S. estuaries. The 10 East Coast case study estuaries represent approximately half of the estuarine watershed area in square miles along the East Coast. The 12 case study estuaries are chosen because of the availability of necessary data and their potential representativeness. This analysis uses the following data for each estuary: (1) total nitrogen load from all sources; (2) direct nitrogen load from atmospheric deposition to the estuary surface; (3) indirect nitrogen load from atmospheric deposition to the estuary watershed and subsequent pass-through to the estuary itself; (4) established nitrogen thresholds and reduction goals adopted by the community; and (5) costs associated with using agreed upon non-point water pollution control technologies.

Atmospheric nitrogen reductions are valued in this analysis on the basis of avoided costs associated with agreed upon controls of nonpoint water pollution sources. Benefits are estimated using an average, locally-based cost for nitrogen removal from water pollution (EPA, 1998). Valuation reflects water pollution control cost avoidance based on average cost/pound of current non-point source water pollution controls for nitrogen in three case study estuaries: Albemarle/Pamlico Sounds, Chesapeake Bay, and Tampa Bay. Taking the weighted cost/pound of these available controls assumes States will combine low cost and high cost controls, which could inflate avoided cost estimates.

In a recent advisory statement, the EPA's Science Advisory Board (SAB), charged with reviewing the benefits methodology for the §812 Prospective report on the benefits and costs of the Clean Air Act Amendments, raised concerns about the use of the avoided cost approach to value reduced ecosystem damages. Specifically, they identified a key requirement which should be met in order for avoided costs to approximate environmental benefits. This requirement is that there is a direct link between implementation of the air pollution regulation and the abandonment of a separate costly regulatory program by some other agency, i.e. a state environmental agency. Reductions in nitrogen deposition from the NOx SIP call are expected to impact estuaries all along the eastern seaboard and the Gulf Coast. Many of the estuaries in these areas are currently being targeted by nitrogen reduction programs due to current impairment of estuarine water quality by excess nutrients. Some of the largest of these estuaries, including the Chesapeake Bay, have established goals for nitrogen reduction and target dates by which these goals should be achieved. Using the best and most easily implemented existing technologies, many of the estuaries will not be able to achieve the stated goals by the target dates. For example, the Chesapeake Bay needs an additional 9,000 tons of nitrogen reductions per year and Long Island Sound needs an additional 3,500 tons of reductions per year. Meeting these additional reductions will require development of new technologies, implementation of costly existing technologies (such as stormwater controls), or use of technologies with significant implementation difficulties, such as

agricultural best management practices (BMPs). Reductions in nitrogen deposition from the atmosphere due to the NOx SIP call will directly reduce the need for these additional costly controls. Thus while the NOx SIP call does not eliminate the need for nutrient management programs already in place, it may substitute for some of the incremental costs and programs (such as an agricultural BMP program) necessary to meet the nutrient reduction goals for each estuary. This then meets the SAB requirement since the NOx SIP call will directly reduce the need for elements of separate costly reduction actions.

EPA believes that the use of an avoided cost approach in this RIA is consistent with the SAB advice for appropriate use of avoided costs. The SAB did not provide direct guidance on alternative approaches to measuring the benefits of reduced nitrogen deposition to estuaries. However, EPA recognizes the fact that avoided costs do not directly measure the benefits of reduced ecological impacts due to nitrogen deposition. Thus, while avoided cost is only a proxy for benefits, and should be viewed as inferior to willingness-to-pay based measures, it is preferred to excluding any quantitative estimate of benefits for this category. Current research is underway to develop other approaches for valuing estuarine benefits, including contingent valuation and hedonic property studies. However, this research is still sparse, and does not contain sufficient information on the marginal willingness-to-pay for changes in concentrations of nitrogen (or changes in water quality or water resources as a result of changes in nitrogen concentrations). As more studies become available, more complete estimates of the commercial and ecological benefits of reduced atmospheric deposition of nitrogen can be incorporated into regulatory analyses.

The fixed capital costs for non-point controls in the case study estuaries is ranged from $0.61 to $45.27 per pound for agricultural and other rural best management practices and from $35 to $142.64 per pound for urban nonpoint source controls (stormwater controls, reservoir management, onsite disposal system changes, onsite BMPs). Using these as a base, the total fixed capital cost per pound (weighted on the basis of fractional relationship of nitrogen load controlled for the estuary goal) is calculated for each of the case-study estuaries and applied in the valuation of their avoided nitrogen load controlled. The weighted capital costs per pound for the case-study estuaries are $32.88 for Albemarle-Pamlico Sounds, $22.31 for Chesapeake Bay, and $88.25 for Tampa Bay[4]. For the purposes of this analysis, EPA assumes that estuaries that have not yet established nutrient reduction goals will utilize the same types of nutrient management programs as projected for the case study estuaries. For the other nine estuaries, an average capital cost per pound of nitrogen (from the three case-estuaries) of $47.65/lb ($105/kg) is calculated and applied; this cost may understate or overstate the costs associated with reductions in these other estuaries. The other nine estuaries generally represent smaller, more urban estuaries (like Tampa Bay), which typically have fewer technical and financial options available to control nitrogen loadings from nonpoint sources. This may result in higher control costs more similar to the Tampa Bay case. On the other hand, these estuaries may have opportunities to achieve additional point source controls at a lower costs. Also, increased public awareness of nutrification issues and technological innovation may, in the future, result in States finding lower cost solutions to nitrogen removal.

[4] The value for Tampa Bay is not a true weighted cost per pound, but a midpoint of a range of $58.54 to $117.65 developed by Apogee Research for the control possibilities (mostly urban BMPs) in the Tampa Bay estuary.

The 12 estuaries directly analyzed represent approximately 48% of the estuarine watershed area along the East Coast (there are 43 East Coast estuaries of which 10 were in the sample, and 31 Gulf of Mexico estuaries of which 2 are in the sample). Because NOAA data indicate that approximately 89% (92.6% by watershed area plus surface area) of East Coast estuaries are highly or moderately nutrient sensitive, it is reasonable to expect that estuaries not included in this analysis would also benefit from reduced deposition of atmospheric nitrogen. Total benefits from the 12 representative estuaries are scaled-up to include the remainder of the nutrient sensitive estuaries along the East Coast (92.6% of all East Coast estuaries) on the basis of estuary watershed plus water surface area. Since the 12 representative estuaries account for 48 percent of total eastern estuarine area, estimates are scaled up by multiplying the estimate for the 12 estuaries by 2.083 and then taking 92.6 percent of this estimate to adjust for nutrient sensitivity.

All capital cost estimates are then annualized based on a 7% discount rate and a typical implementation horizon for control strategies. Based on information from the three case study estuaries, this typically ranges from 5 to 10 years. EPA has used the midpoint of 7.5 years for annualization, which yields an annualization factor of 0.1759. Non-capital installation costs and annual operating and maintenance costs are not included in these annual cost estimates. Depending upon the control strategy, these costs can be significant. Reports on the Albemarle-Pamlico Sounds indicate, for instance, that planning costs associated with control measures comprises approximately 15% of capital costs. Information received from the Association of National Estuary Programs indicates that operating and maintenance costs are about 30% of capital costs, and that permitting, monitoring, and inspections costs are about 1 to 2% of capital costs. For these reasons, the annual cost estimates may be understated.

Table 4-24 presents estimates of monetary benefits arising from the avoided costs of nitrogen removal for the 12 estuaries with directly modeled nitrogen deposition changes and for the full set of 43 East Coast estuaries including extrapolated benefits associated with five regulatory alternatives for the NOx SIP call. Estimates in Table 4-24 assume that 10 percent of nitrogen deposited over the watershed reaches the estuary, costs for non-study estuaries are equal to the average of the costs for the three case studies, and benefits are applied only to nutrient-sensitive estuaries.

Table 4-24
Monetary Benefits Associated with the NOx SIP Call from Avoided Costs of Nitrogen Removal in Eastern Estuaries

Regulatory Alternative	Monetary Benefits (millions 1990$)	
	12 Modeled Eastern Estuaries	Extrapolation to 43 Eastern Estuaries
0.12 Trading	$129	$248
0.15 Trading	$123	$238
Regionality 1	$115	$221
0.20 Trading	$109	$210
0.25 Trading	$79	$152

4.4.4 Household Soiling Damage

Welfare benefits also accrue from avoided air pollution damage, both aesthetic and structural, to architectural materials and to culturally important articles. At this time, data limitations preclude the ability to quantify benefits for all materials whose deterioration may be promoted and accelerated by air pollution exposure. However, this analysis addresses one small effect in this category, the soiling of households by particulate matter.

Assumptions regarding the air quality indicator are necessary to evaluate the concentration-response function. PM_{10} and $PM_{2.5}$ are both components of TSP. However, it is not clear which components of TSP cause household soiling damage. The Criteria Document cites some evidence that smaller particles may be primarily responsible, in which case these estimates are conservative.

Several studies have provided estimates of the cost to households of PM soiling. The study that is cited by ESEERCO (1994) as one of the most sophisticated and is relied upon by EPA in its 1988 Regulatory Impact Analysis for SO_2 is Manuel et al. (1982). Using a household production function approach and household expenditure data from the 1972-73 Bureau of Labor Statistics Consumer Expenditure Survey for over twenty cities in the United States, Manuel et al. estimate the annual cost of cleaning per $\mu g/m^3$ PM per household as $1.26 ($0.48 per person times 2.63 persons per household). This estimate is low compared with others (e.g., estimates provided by Cummings et al., 1981, and Watson and Jaksch, 1982, are about eight times and five times greater, respectively). The ESEERCO report notes, however, that the Manuel estimate is probably downward biased because it does not include the time cost of do-it-yourselfers. Estimating that these costs may comprise at least half the cost of PM-related cleaning costs, they double the Manuel estimate to obtain a point estimate of $2.52 (reported by ESEERCO in 1992 dollars as $2.70).

Table 4-25 presents estimates of monetary benefits arising from the avoided household soiling associated with the five regulatory alternatives for the NOx SIP call. Household soiling benefits are not affected by the threshold assumption.

Table 4-25
Monetary Benefits from Reduced Household Soiling Associated with the NOx SIP Call

Regulatory Alternative	Monetary Benefits (millions 1990$)	
	RADM-RPM	S-R Matrix
0.12 Trading	$26	$11
0.15 Trading	$10	$7
Regionality 1	$10	$6
0.20 Trading	$10	$6
0.25 Trading	$7	$6

4.4.5 Visibility

Visibility effects are measured in terms of changes in deciview, a measure useful for comparing the effects of air quality on visibility across a range of geographic locations. This measure is directly related to two other common visibility measures: visual range (measured in km) and light extinction (measured in km^{-1}). The deciview measure characterizes visibility in terms of perceptible changes in haziness independent of baseline conditions. Based on the deciview measure, two types of valuation estimates are applied to the expected visibility changes: residential visibility and recreational visibility.

Visibility is a function of the ability of gases and aerosols to scatter and absorb light. RPM only computes the loss of visibility due to sulfates, nitrates, organic matter, and elemental carbon, but not other variables, such as coarse PM and fine soil. By not including these other terms, the resulting estimates of WTP for residential and recreational visibility improvement are overestimated. Based on the full suite of variables available at IMPROVE sites, the WTP estimates should, on average, be multiplied by 0.82 to correct for this bias. The range of correction factors is from 0.40 to 1.00, depending on the site and to a lesser extent the policy alternative. Similarly, when calculating residential visibility, the S-R matrix estimate includes terms for sulfates, nitrates and coarse PM, but does not include organic matter and other variables. The results from the IMPROVE monitors suggest that to correct this bias, the WTP estimates should be multiplied by 0.65 at the mean, with the correction factors ranging from 0.28 to 1.00. Note that the S-R matrix *recreational* visibility estimates include the full suite of visibility variables, so no correction is necessary.

Residential Visibility

The residential visibility valuation estimate is derived from the results of an extensive visibility study (McClelland et al., 1991). A household WTP value is derived by dividing the value reported in McClelland et al. by the corresponding hypothesized change in deciview, yielding an estimate of $14 per unit change in deciview. This WTP value is applied to all households in any area estimated to experience a change in visibility.

Table 4-26 presents estimates of monetary benefits arising from improvements in residential visibility due to reductions in PM associated with the five regulatory alternatives for the NOx SIP call. Table 4-26 includes both unadjusted visibility values and values adjusted based on the average adjustment factor Of 0.82 for the RADM-RPM set and 0.65 for the S-R Matrix set.

Table 4-26
Monetary Benefits from Improved Residential Visibility Associated with the NOx SIP Call

Regulatory Alternative	Monetary Benefits (millions 1990$)			
	RADM-RPM		S-R Matrix	
	Unadjusted	Adjusted	Unadjusted	Adjusted
0.12 Trading	$144	$118	$92	$60
0.15 Trading	$34	$28	$59	$38
Regionality 1	$42	$34	$41	$27
0.20 Trading	$46	$38	$48	$31
0.25 Trading	$30	$25	$46	$30

Recreational Visibility

The value of visibility improvements in certain National Parks in the Southeast is based on the results of a 1990 Cooperative Agreement project jointly funded by the EPA and the National Park Service, “Preservation Values For Visibility Protection at the National Parks”. Based on that contingent valuation study of visibility improvements, Chestnut (1997) calculates a household willingness to pay (WTP) for visibility improvements, capturing both use and non-use recreational values, and accounts for geographic variations in the willingness to pay. This method was used in the PM and ozone NAAQS RIA analysis, and is adopted for the SIP call benefits analysis.

The Preservation Values study examined the demand for visibility in three broad regions of the country, but only the Southeast region is directly relevant for the SIP call. Respondents both inside and outside the Southeast region were asked their willingness to pay to protect visibility at four National Parks in the region: Shenandoah, Mammoth Cave, Great Smoky Mountains, and Everglades National Parks. Photos from Shenandoah (the “indicator park” in the Southeast region) were provided as part of

the survey instrument. Respondents were first asked for their value for preserving "only visibility at National Parks in the Southeast". They were later asked to state what portion of their stated total value was for visibility at the indicator park alone. Prior to providing their values, respondents were instructed that "These questions concern only visibility at national parks in the Southeast and assume there will be no change in visibility at national parks in other regions. Other households are being asked about visibility, human health and vegetation protection in urban areas and at national parks in other regions". Therefore, the estimated valuation functions for the Southeastern National Parks are specifically designed to be in addition to any value for urban visibility. Note that the total value of recreational visibility improvements in Southeastern National Parks is the sum of the value for indicator and non-indicator parks. The high Southeast recreational visibility estimate applies the "in-region" value for Southeastern visibility changes to the total population inside the Southeastern region, and the "out-of-region" value for Southeastern visibility changes to all other populations in the U.S. The total in-region WTP per household is $6.50 per deciview change, while the total out-of-region WTP per household is $4 per deciview change.

To take into account the possibility that the study did not fully account for double-counting, the low Southeast recreational visibility estimate will apply values of non-Southeast residents for Southeastern National Parks to populations both in and out of the Southeast region. The out-of-region value should not include any value for improved residential visibility, because non-Southeast residents, by definition, live outside the region, and thus are not included in the Southeast residential visibility calculation.

Table 4-27 presents estimates of monetary benefits arising improvements in recreational visibility due to reductions in PM associated with the five regulatory alternatives for the NOx SIP call. Table 4-27 includes both unadjusted visibility values and values adjusted based on the average adjustment factor of 0.82 for the RADM-RPM set. As described in the beginning of this section, recreational visibility results generated using the S-R Matrix do not need to be adjusted.

Table 4-27
Monetary Benefits from Improved Visibility in National Parks in the Southeast Associated with the NOx SIP Call

Regulatory Alternative	Monetary Benefits (millions 1990$)					
	RADM-RPM				S-R Matrix	
	Unadjusted		Adjusted			
	Low	High	Low	High	Low	High
0.12 Trading	$64	$77	$52	$63	$21	$22
0.15 Trading	$36	$43	$30	$35	$15	$15
Regionality 1	$40	$49	$33	$40	$11	$10
0.20 Trading	$36	$43	$30	$35	$14	$14
0.25 Trading	$28	$34	$23	$28	$12	$11

The SIP call will impact visibility at other national parks than the specific parks examined in the Preservation Values Study's Southeast region. Visibility conditions will improve at additional national parks and recreation areas in the Southeast, as well as parks in the Northeast and Midwest. The air quality model (RADM-RPM and S-R Matrix) used to estimate visibility improvements produces estimates of the improvements at all locations throughout the SIP call region. However, there are no direct valuation studies available for these other areas.

To explore the potential magnitude of the value of improved visibility outside the Preservation Values Study's Southeast region, valuation information about the demand for visibility in the Southeast from the Preservation Values study is used to approximate the value of visibility improvements at national parks outside the Southeast. In order to account for geographic variability in WTP, the Preservation Values valuation method divided the recreational areas of the United States into three regions. Separate values were estimated for households living in each region, as well as for households living in other parts of the United States for visibility improvements in each region. In-region respondents placed higher values on visibility improvements at a local recreational area than out-of-region respondents. The lowest resident and non-resident values for any national parks examined in the Preservation Values study was for visibility in the Southeast. The out-of-region values in the Southeast will be used as an approximation of the value of national parks in the Central and Northeastern U.S. that are impacted by the NOx SIP call.

For the low Central and Northeastern recreational visibility estimates, out-of-region values per household for the Southeastern non-indicator parks (equal to 60 percent of the total value per deciview, or $2.40) are used to approximate the value to populations both outside and inside the Central and Northeastern U.S. of visibility at Central and Northeastern national parks. Out-of-region values are used for both sets of populations to avoid the possibility of double-counting benefits already accounted for in

the calculation of residential visibility benefits. Non-indicator park values are used to account for the fact that indicator parks in a region may have unique values relative to non-indicator parks and therefore values for these indicator parks are not appropriate to transfer to non-indicator parks. For the high Central and Northeastern recreational visibility estimates, out-of-region values per household for the Southeastern non-indicator parks are used to approximate the value to populations outside the Central and Northeastern U.S. of visibility at Central and Northeastern national parks, and in-region values per household for the Southeastern non-indicator parks are used to approximate the value to populations within the Central and Northeastern U.S. The sum of monetary benefits for Southeast and Central and Northeastern visibility benefits will be used in the calculation of total benefits.

Table 4-28 presents the recreational visibility values for national parks outside the Southeast. Table 4-28 includes both unadjusted visibility values and values adjusted based on the average adjustment factor of 0.82 for the RADM-RPM set. As described in the beginning of this section, recreational visibility results generated using the S-R Matrix do not need to be adjusted. Recreational visibility benefits are predicted to be reduced when using the S-R Matrix generated visibility changes. This is due to predicted increases in PM in Minnesota and Maine, where two of the major parks outside the Southeast are located.

Total low-end recreational visibility benefits (Southeast plus Northeast) using RADM-RPM generated visibility changes range from $24 million for the 0.25 trading alternative to $71 million for the 0.12 trading alternative. Total RADM-RPM based high-end recreational visibility benefits range from $29 million for the 0.25 trading alternative to $85 million for the 0.12 trading alternative. Total S-R Matrix based low-end recreational visibility benefits range from $5 million for the Regionality 1 alternative to $22 million for the 0.12 trading alternative. Total S-R Matrix based high-end recreational visibility benefits range from $2 million for the Regionality 1 alternative to $21 million for the 0.12 trading alternative.

Table 4-28
Monetary Benefits Associated with Visibility Changes in National Parks Outside the Southeast in the NOx SIP Call Region

Regulatory Alternative	Monetary Benefits (millions 1990$)					
	RADM-RPM				S-R Matrix	
	Unadjusted		Adjusted			
	Low	High	Low	High	Low	High
0.12 Trading	$22.8	$27.0	$18.7	$22.1	$0.5	$0.6
0.15 Trading	$13.4	$15.9	$11.0	$13.0	$-5.4	$-6.4
Regionality 1	$7.1	$8.5	$5.8	$7.0	$-6.5	$-7.7
0.20 Trading	$8.3	$9.8	$6.8	$8.0	$-5.8	$-6.9
0.25 Trading	$1.3	$1.6	$1.1	$1.3	$-5.2	$-6.2

4.5 Total Benefits

The dollar benefits from reducing ozone and PM levels resulting from implementing the SIP call NOx reductions is the sum of dollar benefits from the reductions in incidence of all non-overlapping health and welfare endpoints associated with PM and ozone for a given set of assumptions. If two endpoints are overlapping, then adding the benefits associated with each will result in double counting of some benefits. Although study-specific point estimates of dollar benefits associated with specific, possibly overlapping endpoints are presented separately, estimation of total benefits requires that the benefits from only non-overlapping endpoints be included in the total. Four non-overlapping broad categories of health and welfare endpoints will be included in the estimation of total dollar benefits for the SIP call: (1) mortality, (2) hospital admissions, (3) respiratory symptoms/illnesses not requiring hospital admission, and (4) welfare endpoints. When considering only point estimates, aggregation of the benefits from different endpoints is relatively straightforward. Once a set of non-overlapping categories is determined, the point estimate of the total benefits associated with the health and welfare endpoints in the set is just the sum of the endpoint-specific point estimates. If each endpoint-specific point estimate is the mean of a distribution of dollar benefits associated with that endpoint, then the point estimate of total dollar benefits is just the sum of those means.

There is uncertainty about the magnitude of the total monetized benefits associated with any of the SIP call regulatory alternatives examined in the benefits analysis. The benefits are uncertain because there is uncertainty surrounding each of the factors that affect these benefits: the changes in ambient pollutant concentrations that will result from the SIP call implementation; the relationship between these changes in pollutant concentrations and each of the associated health and welfare endpoints; and the value of each adverse health and welfare effect avoided by the reduction in pollutant concentrations.

Much of the uncertainty derives from uncertainty about the true values of analysis components, such as the value of the ozone coefficient in a concentration-response function relating ozone to a particular health endpoint, or the true dollar value of an avoided hospital admission for congestive heart failure. The analysis relies on estimates of these parameters, but the true values being estimated are unknown. This type of uncertainty can often be quantified. For example, the uncertainty about pollutant coefficients is typically quantified by reported standard errors of the estimates of the coefficients in the concentration-response functions estimated by epidemiological studies. Appendix A presents a formal quantitative analysis of the statistical uncertainty imparted to the benefits estimates by the variability in the underlying concentration-response and valuation functions.

Some of the uncertainty surrounding the results of a benefits analysis, however, involves basically discrete choices and is less easily quantified. For example, the decision of which air quality model to use to generate changes in ambient PM concentrations is a choice between two models, embodying discrete sets of air chemistry and mathematical assumptions. Decisions and assumptions must be made at many points in an analysis in the absence of complete information. The estimate of total benefits is sensitive to the decisions and assumptions made. Among the most critical of these are the following:

1. **Ozone mortality:** There is some uncertainty surrounding the existence of a relationship between tropospheric ozone exposure and premature mortality. The two possible assumptions are: (1) that there is no relationship between ozone and mortality; and (2) that there is a potential relationship between ozone and mortality, which we can quantify based on the meta-analysis of current U.S. ozone mortality studies.

2. **Ozone agriculture effects:** The existing set of exposure-response functions relating crop yields to changes in ozone exposure include both ozone-sensitive and ozone-insensitive cultivars. Possible assumptions are: (1) plantings of commodity crop cultivars are primarily composed of sensitive varieties; (2) plantings of commodity crop cultivars are primarily composed of non-sensitive varieties.

3. **$PM_{2.5}$ concentration threshold:** Health effects are measured only down to the assumed ambient concentration threshold. Changes in air quality below the threshold will have no impact on estimated benefits. EPA's Science Advisory Board has recommended examining alternative thresholds, including background and 15 $\mu g/m^3$.

4. **Sulfate Dominance:** There are two possible interpretations of PM-related health and welfare benefits depending on the model used to assess air quality changes: (1) results generated with RADM-RPM are indicative of a future eastern U.S. atmosphere where acid sulfate levels are still high enough to control atmospheric chemistry, and more specifically ammonium nitrate particle formation. In this circumstance, reductions in NOx emissions may result in non-linear responses in total fine particle levels, involving both decreases and increases; and (2) results generated with the Source-Receptor Matrix are indicative of a future eastern U.S. atmosphere where acid sulfate levels do not dominate particle formation chemistry. In this case, reductions in NOx emissions would be expected to result more directly in linear reductions in PM.

5. **Recreational visibility:** Recreational visibility benefits for residents of the Southeast may overlap with "residential" visibility benefits. Two alternative assumptions may be considered for in-region residents: (1) recreational visibility benefits overlap with residential visibility benefits, and to avoid this overlap, the recreational visibility value of $4 per deciview for out-of-region residents is used for *in-region* residents ($2.40 for non-indicator parks, and $1.60 for the indicator park); or (2) recreational visibility benefits are in addition to residential visibility benefits, and the in-region value of $6.50 is used ($3.25 for non-indicator parks, and $3.25 for the indicator park).

Benefits from visibility improvements may also occur in NOx SIP call states outside of the Southeast. The current literature on the value of recreational visibility in national parks is limited to studies of values in California, the Southwest, and the Southeast, and thus excludes the Central and Northeast (CNE) portion of the NOx SIP call region. Three alternative assumptions may be considered when valuing visibility changes in the CNE: (1) recreational visibility values in the CNE are much less than that in the Southeast and therefore to insure benefits are not overstated, no value should be associated with visibility changes in the CNE; (2) recreational visibility values in the CNE are similar to the values for non-indicator parks in the Southeast, *and* recreational and residential benefits *overlap*: people in and out of the CNE region value CNE recreational visibility at $2.40 per deciview; or (3) recreational visibility values in the CNE are similar to the values for non-indicator parks in the Southeast, and there is *no overlap* of recreational and residential benefits: the in-region CNE value is based on the Southeast in-region value of $3.25 per deciview, and the out-of-region CNE value is based on the Southeast out-of-region value of $2.40 per deciview.

Tables 4-29 through 4-33 present summaries of the endpoint specific monetary values and the estimate of total benefits for each of the five regulatory alternatives. Aggregate results are presented for two assumption sets: 1) a "low" assumption set reflecting the assumptions that human health and the environment have low responsiveness to changes in ambient air quality, and 2) a "high" assumption set reflecting the assumptions that human health and the environment are highly responsive to changes in ambient air quality. The "low" assumption set includes the following assumptions: 1) there are no PM-related health effects occurring below a threshold of 15 $\mu g/m^3$, 2) changes in PM concentrations are more accurately represented by the RADM-RPM air quality model, 3) there is no relationship between ozone and premature mortality, 4) agricultural commodity crops are less sensitive to ozone, 5) Southeastern recreational visibility values are not transferable to changes in recreational visibility in the Northeast and Central U.S., and 6) the low-end recreational visibility valuation method is correct. The "high" assumption set includes the following assumptions: 1) PM-related health effects occur down to the anthropogenic background threshold, 2) changes in PM concentrations are more accurately represented by the S-R Matrix air quality model, 3) the relationship between ozone and premature mortality is characterized by the distribution of avoided incidences derived from the ozone mortality meta-analysis, 4) agricultural commodity crops are more sensitive to ozone, 5) Southeastern recreational visibility values are transferable to the Northeastern and Central U.S., and 6) the high-end recreational visibility method is correct.

Table 4-29
Total Quantified Monetary Benefits Associated with the NOx SIP Call, Incremental to the 2007 Base Case: 0.12 Trading Regulatory Alternative[a]

Endpoint	Monetary Benefits (million 1990$)	
	"Low" Assumption Set	"High" Assumption Set
Ozone-related Endpoints		
Short-term mortality	$0	$1,496
Hospital admissions	$5	$5
Acute respiratory symptoms	$1	$1
Worker productivity	$25	$25
Commodity crops	$53	$415
Commercial forests	$233	$233
PM-related Endpoints		
Long-term mortality	$1,468	$2,672
Hospital admissions	$3	$4
Chronic bronchitis	$589	$245
Acute bronchitis	$0	$0
Acute respiratory symptoms	$0	$0
Work loss days	$14	$8
MRADs	$53	$29
Household soiling	$26	$11
Residential visibility	$118	$60
Recreational visibility	$52	$21
Nitrogen deposition	$248	$248
TOTAL	**$2,888**	**$5,473**

[a] Not all possible benefits are quantified and monetized in this analysis. Potential benefit categories that have not been quantified and monetized are listed in Table 4-2.

Table 4-30
Total Quantified Monetary Benefits Associated with the NOx SIP Call, Incremental to the 2007 Base Case: 0.15 Trading Regulatory Alternative[a]

Endpoint	Monetary Benefits (million 1990$)	
	"Low" Assumption Set	"High" Assumption Set
Ozone-related Endpoints		
Short-term mortality	$0	$1,326
Hospital admissions	$4	$4
Acute respiratory symptoms	$1	$1
Worker productivity	$22	$22
Commodity crops	$47	$361
Commercial forests	$213	$213
PM-related Endpoints		
Long-term mortality	$251	$1,763
Hospital admissions	$1	$4
Chronic bronchitis	$225	$160
Acute bronchitis	$0	$0
Acute respiratory symptoms	$0	$0
Work loss days	$6	$5
MRADs	$24	$19
Household soiling	$10	$7
Residential visibility	$28	$38
Recreational visibility	$30	$9
Nitrogen deposition	$238	$238
TOTAL	**$1,100**	**$4,170**

[a] Not all possible benefits are quantified and monetized in this analysis. Potential benefit categories that have not been quantified and monetized are listed in Table 4-2.

Table 4-31
Total Quantified Monetary Benefits Associated with the NOx SIP Call, Incremental to the 2007 Base Case: Regionality 1 Regulatory Alternative[a]

Endpoint	Monetary Benefits (million 1990$)	
	"Low" Assumption Set	"High" Assumption Set
Ozone-related Endpoints		
Short-term mortality	$0	$1,191
Hospital admissions	$4	$4
Acute respiratory symptoms	$1	$1
Worker productivity	$20	$20
Commodity crops	$43	$318
Commercial forests	$188	$188
PM-related Endpoints		
Long-term mortality	$317	$1,326
Hospital admissions	$1	$4
Chronic bronchitis	$236	$122
Acute bronchitis	$0	$0
Acute respiratory symptoms	$0	$0
Work loss days	$6	$4
MRADs	$24	$15
Household soiling	$10	$6
Residential visibility	$34	$27
Recreational visibility	$33	$10
Nitrogen deposition	$221	$221
TOTAL	**$1,138**	**$3,457**

[a] Not all possible benefits are quantified and monetized in this analysis. Potential benefit categories that have not been quantified and monetized are listed in Table 4-2.

Table 4-32
Total Quantified Monetary Benefits Associated with the NOx SIP Call, Incremental to the 2007 Base Case: 0.20 Trading Regulatory Alternative[a]

Endpoint	Monetary Benefits (million 1990$)	
	"Low" Assumption Set	"High" Assumption Set
Ozone-related Endpoints		
Short-term mortality	$0	$1,108
Hospital admissions	$4	$4
Acute respiratory symptoms	$1	$1
Worker productivity	$20	$20
Commodity crops	$42	$312
Commercial forests	$185	$185
PM-related Endpoints		
Long-term mortality	$370	$1,499
Hospital admissions	$1	$4
Chronic bronchitis	$216	$135
Acute bronchitis	$0	$0
Acute respiratory symptoms	$0	$0
Work loss days	$5	$4
MRADs	$24	$17
Household soiling	$10	$6
Residential visibility	$38	$31
Recreational visibility	$30	$7
Nitrogen deposition	$210	$210
TOTAL	**$1,156**	**$3,543**

[a] Not all possible benefits are quantified and monetized in this analysis. Potential benefit categories that have not been quantified and monetized are listed in Table 4-2.

Table 4-33
Total Quantified Monetary Benefits Associated with the NOx SIP Call, Incremental to the 2007 Base Case: 0.25 Trading Regulatory Alternative[a]

Endpoint	Monetary Benefits (million 1990$)	
	"Low" Assumption Set	"High" Assumption Set
Ozone-related Endpoints		
Short-term mortality	$0	$824
Hospital admissions	$3	$3
Acute respiratory symptoms	$1	$1
Worker productivity	$14	$14
Commodity crops	$34	$242
Commercial forests	$143	$143
PM-related Endpoints		
Long-term mortality	$208	$1,400
Hospital admissions	$1	$4
Chronic bronchitis	$148	$127
Acute bronchitis	$0	$0
Acute respiratory symptoms	$0	$0
Work loss days	$4	$4
MRADS	$14	$16
Household soiling	$7	$6
Residential visibility	$25	$30
Recreational visibility	$23	$5
Nitrogen deposition	$152	$152
TOTAL	**$777**	**$2,971**

[a] Not all possible benefits are quantified and monetized in this analysis. Potential benefit categories that have not been quantified and monetized are listed in Table 4-2.

4.6 Limitations of the Analysis

Given incomplete information, this national benefits analysis yields approximate results because of the uncertainty associated with any estimate. Potentially important sources of uncertainty exist and many of these are summarized in Table 4-34. In most cases, there is no

apparent bias associated with the uncertainty. For those cases for which the nature of the uncertainty suggests a direction of possible bias, this direction is noted in the table.

4.6.1 Projected Income Growth

This analysis does not attempt to adjust benefits estimates to reflect expected growth in real income. Economic theory argues, however, that WTP for most goods (such as environmental protection) will increase if real incomes increase. The degree to which WTP may increase for the specific health and welfare benefits provided by the NOx SIP call cannot be estimated due to insufficient income elasticity information. Thus, all else being equal, the benefit estimates presented in this analysis are likely to be understated.

4.6.2 Unquantifiable Benefits

In considering the monetized benefits estimates, the reader should be aware that many limitations for conducting these analyses are mentioned throughout this RIA. One significant limitation of both the health and welfare benefits analyses is the inability to quantify many PM and ozone-induced adverse effects. Table 4-2 lists the categories of benefits that this analysis is able to quantify and those discussed only in a qualitative manner. In general, if it were possible to include the unquantified benefits categories in the total monetized benefits, the benefits estimates presented in this RIA would increase. Specific examples of unquantified benefits explored in more detail below include other human health effects, urban ornamentals, aesthetic injury to forests, nitrogen in drinking water, and brown clouds.

The benefits of reductions in a number of ozone- and PM-induced health effects have not been quantified due to the unavailability of concentration-response and/or economic valuation data. These effects include: reduced pulmonary function, morphological changes, altered host defense mechanisms, cancer, other chronic respiratory diseases, infant mortality, airway responsiveness, increased susceptibility to respiratory infection, pulmonary inflammation, acute inflammation and respiratory cell damage, and premature aging of the lungs.

Table 4-34
Sources of Uncertainty in the Benefit Analysis

1. Uncertainties Associated With Concentration-Response Functions
There is uncertainty surrounding the ozone or PM coefficient in each C-R function. There is uncertainty about applying a single C-R function to pollutant changes and populations in all locations. It is uncertain how similar future year C-R relationships will be to current concentration-response relationships. The correct functional form of each C-R relationship is uncertain. For example, it is uncertain whether there are thresholds and, if so, what they are. There is uncertainty associated with extrapolation of C-R relationships beyond the range of ozone or PM concentrations observed in the study.
2. Uncertainties Associated With Daily Ozone and PM Concentrations
There is uncertainty surrounding the projected hourly ozone and daily PM concentrations. The changes in ozone and PM concentrations resulting from the SIP call provisions are uncertain.
3. Uncertainties Associated With Possible Lagged Effects
It is uncertain what portion of the PM-related long-term exposure mortality effects associated with changes in annual PM levels would occur in a single year, and what portion might occur in subsequent years.
4. Uncertainties Associated With Baseline Incidence Rates
Some baseline incidence rates are not location-specific (e.g., those taken from studies) and may therefore not accurately represent the actual location-specific rates. It is uncertain how well current baseline incidence rates approximate what baseline incidence rates will be in the year 2007, given either "as is" ozone and PM concentrations or any alternative SIP call scenario. It is uncertain how well the projected population and demographics, used to derive incidences, approximate what the actual population and demographics will be in the year 2007.
5. Uncertainties Associated With Economic Valuation
Unit dollar values associated with health and welfare endpoints are only estimates of MWTP and therefore have uncertainty surrounding them. Possible directions of bias are discussed in the technical support document (Abt Associates, 1998a). Even using constant dollars (e.g., 1990 dollars), it is uncertain whether MWTP for each type of risk reduction will be the same in the year 2007 as the current MWTP. There is uncertainty about the appropriate discount rate for benefits achieved in the future (2007).
6. Uncertainties Associated With Aggregation of Monetized Benefits

Because benefit estimation is limited to those health and welfare endpoints for which concentration-response functions have been estimated, there may be components of total benefit omitted. This would lead to a downward bias in the estimated total monetized benefit.

In addition to the above non-monetized health benefits, there are a number of non-monetized welfare benefits of NOx emission controls from reduced adverse effects on vegetation, forests, and other natural ecosystems. The CAA and other statutes, through requirements to protect natural and ecological systems, indicate that these are scarce and highly valued resources. Lack of comprehensive information, insufficient valuation tools, and significant uncertainties result in understated welfare benefits estimates in this RIA. However, a number of expert biologists, ecologists, and economists (Costanza, 1997) argue that the benefits of protecting natural resources are enormous and increasing as ecosystems become more stressed and scarce in the future. Additionally, agricultural, forest and ecological scientists (Heck, 1997) believe that vegetation appears to be more sensitive to ozone than humans and consequently, that damage is occurring to vegetation and natural resources at concentrations below the ozone NAAQS. Experts also believe that the effect of ozone on plants is both cumulative and long-term. The specific non-monetized benefits from reductions in ambient ozone concentrations would accrue from: decreased foliar injury; averted growth reduction of trees in natural forests; maintained integrity of forest ecosystems (including habitat for native animal species); and the aesthetics and utility of urban ornamentals (e.g., grass, flowers, shrubs and trees). Other welfare categories for which there is incomplete information to estimate the economic value of reduced adverse effects include: existence value of Class I areas; materials damage; reduced sulfate deposition to aquatic and terrestrial ecosystems; and visibility impairment due to "brown clouds" (i.e., distinct brown layers of trapped air pollutants close to the ground).

Other Human Health Effects

Human exposure to PM and ozone is known to cause health effects such as: airway responsiveness, increased susceptibility to respiratory infection, acute inflammation and respiratory cell damage, premature aging of the lungs and chronic respiratory damage. An improvement in ambient PM and ozone air quality is expected to reduce the number of incidences within each effect category that the U.S. population would experience. Although these health effects are known to be PM or ozone-induced, concentration-response data is not available for quantifying the benefits associated with reducing these effects. The inability to quantify these effects leads to an underestimation of the monetized benefits presented in this analysis.

Urban Ornamentals

Urban ornamentals represent an additional vegetation category likely to experience some degree of effects associated with exposure to ambient ozone levels and likely to impact large economic sectors. In the absence of adequate exposure-response functions and economic damage functions for the potential range of effects relevant to these types of vegetation, no direct quantitative economic benefits analysis has been conducted. Ornamentals used in the urban and suburban landscape include shrubs, trees, grasses, and flowers. The types of economic losses that could potentially result from effects that have been associated with ozone exposure include: 1) reduction in aesthetic services over the realized lifetime of a plant; 2) the loss of aesthetic services resulting from the premature death (or early replacement) of an injured plant; 3) the cost associated with removing the injured plant and replacing it with a new plant; 4) increased soil erosion, 5) increased energy costs from loss of shade in the urban environment; 6) reduced seedling survivability; and 7) any additional costs incurred over the lifetime of the injured plant to mitigate the effects of ozone-induced injury. It is estimated that more than $20 billion (1990 dollars) are spent annually on landscaping using ornamentals (Abt Associates, 1995), both by private property owners/tenants and by governmental units responsible for public areas, making this a potentially important welfare effects category. However, information and valuation

methods are not available to allow for plausible estimates of the percentage of these expenditures that may be related to impacts associated with ozone exposure.

Aesthetic Injury to Forests

Ozone is a regionally dispersed air pollutant that has been shown conclusively to cause discernible injury to forest trees (Fox, 1995). One of the welfare benefits expected to accrue as a result of reductions in ambient ozone concentrations in the United States is the economic value the public receives from reduced aesthetic injury to forests. There is sufficient scientific information available that ambient ozone levels cause visible injury to foliage and impair the growth of some sensitive plant species. Ozone inhibits photosynthesis and interferes with nutrient uptake, causing a loss in vigor that affects the ability of trees to compete for resources and makes them more susceptible to a variety of stresses (EPA, 1996a, p. 5-251). Extended or repeated exposures may result in decline and eventual elimination of sensitive species. Ozone concentrations of 0.06 ppm or higher are capable of causing injury to forest ecosystems.

The most notable effects of ozone on forest aesthetics and ecosystem function have been documented in the San Bernardino Mountains in California. Visible ozone-related injury, but not necessarily ecosystem effects, have also been observed in the Sierra Nevada in California, the Appalachian Mountains from Georgia to Maine, the Blue Ridge Mountains in Virginia, the Great Smoky Mountains in North Carolina and Tennessee, and the Green Mountains in Vermont (EPA, 1996a, pp. 5-250 to 5-251). These are all locations where there is substantial recreation use and where scenic quality of the forests is an important characteristic of the resource. Economic valuation studies of lost aesthetic value of forests attributed to plant injuries caused by ozone are limited to two studies conducted in Southern California (Crocker, 1985; Peterson et al., 1987). Both included contingent valuation surveys that asked respondents what they would be willing to pay for reductions in (or preventions of increases in) visible ozone injuries to plants. Crocker found that individuals are willing to pay a few dollars more per day to gain access to recreation areas with only slight ozone injury instead of areas with moderate to severe injury. Peterson et al. estimated that a one-step change (on a 5 point scale) in visible ozone injury in the San Bernardino and Angeles National Forests would be valued at an aggregate amount of between $27 million and $144 million for all residents of Los Angeles, Orange, and San Bernardino counties. A reassessment of the survey design, in light of current standards for contingent valuation research, suggests that it is plausible that concerns for forest ecosystems and human health could have been embedded into these reported values. The extent of this possible bias is uncertain.

Present analytic tools and resources preclude EPA from quantifying the benefits of improved forest aesthetics in the eastern U.S. expected to occur from the NOx SIP call. This is due to limitations in our ability to quantify the relationship between ozone concentrations and visible injury, and limited quantitative information about the value to the public of specific changes in visible aesthetic quality of forests. However, there is sufficient supporting evidence in the physical sciences and economic literature to support the finding that the proposed NOx SIP call can be expected to reduce injury to forests, and that reductions in these injuries will likely have a significant economic value to the public.

Nitrates in Drinking Water

Nitrates in drinking water are currently regulated by a maximum contaminant level (MCL) of 10 mg/L on the basis of the risk to infants of methemoglobinemia, a condition which adversely affects the blood's oxygen carrying capacity. In an analysis of pre-1991 data, Raucher,

et al. (1993) found that approximately 2 million people were consuming public drinking water supplies which exceed the MCL. Supplementing these findings, the National Research Council concluded that 42 percent of the public drinking water users in the U.S. (approximately 105 million people) are either not exposed to nitrates or are exposed to concentrations below 1.3 mg/L (National Research Council, 1995).

In a recent epidemiological study by the National Cancer Institute, a statistically significant relationship between nitrates in drinking water and incidence of non-Hodgkin's lymphoma were reported (Ward, et al., 1996). Though it is generally acknowledged that traditional water pollution sources such as agricultural runoff are mostly responsible for violations of the MCL, other more diffuse sources of nitrate to drinking water supplies, such as that from atmospheric deposition, may also become an important health concern should the cancer link to nitrates be found valid upon further study.

Brown Clouds

NOx emissions, especially gaseous NO_2 and NOx aerosols, can cause a brownish color to appear in the air (EPA, 1996c). In higher elevation western cities where wintertime temperature inversions frequently trap air pollutants in atmospheric layers close to the ground, this can result in distinct brown layers. In the eastern U.S., a layered look is not as common, but the ubiquitous haze sometimes takes on a brownish hue. To date, economic valuation studies concerning visual air quality have focused primarily on the clarity of the air, and have not addressed the question of how the color of the haze might be related to aesthetic degradation. It may be reasonable to presume that brown haze is likely to be perceived as dirty air and is more likely to be associated with air pollution in people's minds. It has not, however, been established that the public would have a greater value for reducing brown haze than for a neutral colored haze. Results of economic valuation studies of visibility aesthetics conducted in Denver and in the eastern U.S. (McClelland et al., 1991) are not directly comparable because changes in visibility conditions are not defined in the same units of measure. However, the WTP estimates for improvements in visibility conditions presented in this assessment are based on estimates of changes in clarity of the air (measured as deciview) and do not take into account any change in color that may occur. It is possible that there may be some additional value for reductions in brownish color that may also occur when NOx emissions are reduced.

Other Unquantifiable Benefits Categories

There are other welfare benefits categories for which there is incomplete information to permit a quantitative assessment for this analysis. For some endpoints, gaps exist in the scientific literature or key analytical components and thus do not support an estimation of incidence. In other cases, there is insufficient economic information to allow estimation of the economic value of adverse effects. Potentially significant, but unquantified welfare benefits categories include: existence and user values related to the protection of Class I areas (e.g., Shenendoah National Park), damage to tree seedlings of more than 10 sensitive species (e.g., black cherry, aspen, ponderosa pine), non-commercial forests, ecosystems, materials damage, and reduced sulfate deposition to aquatic and terrestrial ecosystems. Although scientific and economic data are not available to allow quantification of the effect of ozone in these categories, the expectation is that, if quantified, each of these categories would lead to an increase in the monetized benefits presented in this RIA.

4.6.3 Potential Disbenefits

In this discussion of unquantified benefits, a discussion of potential disbenefits must also be mentioned. Several of these disbenefit categories are related to nitrogen deposition while one category is related to the issue of ultraviolet light.

Passive Fertilization

Several disbenefit categories are related to nitrogen deposition. Nutrients deposited on crops from atmospheric sources are often referred to as passive fertilization. Nitrogen is a fundamental nutrient for primary production in both managed and unmanaged ecosystems. Most productive agricultural systems require external sources of nitrogen in order to satisfy nutrient requirements. Nitrogen uptake by crops varies, but typical requirements for wheat and corn are approximately 150 kg/ha/yr and 300 kg/ha/yr, respectively (NAPAP, 1990). These rates compare to estimated rates of passive nitrogen fertilization in the range of 0 to 5.5 kg/ha/yr (NAPAP, 1991). So, for these crops, deposited nitrogen could account for as much as 2 to 4 percent of nitrogen needs. Holding all other factors constant, farmers' use of purchased fertilizers or manure may increase as deposited nitrogen is reduced. EPA has not estimated the potential value of this possible increase in the use of purchased fertilizers, but a qualitative assessment of several factors suggests that the overall value is very small relative to the value of other health and welfare endpoints presented in this analysis. First, reductions in NOx emissions affect only a fraction of total nitrogen deposition. Approximately 70 to 80 percent of nitrogen deposition is in the form of nitrates (and thus can be traced to NOx emissions) while most of the remainder is due to ammonia emissions (personal communication with Robin Dennis, NOAA Atmospheric Research Lab, 1997). Table 3-4 in Chapter 3 indicates the annual average change in nitrogen deposition attributable to the 0.15 Trading alternative of the NOx SIP call is about 11 percent of baseline levels, suggesting a relatively small potential change in passive fertilization. Second, some sources of nitrogen, such as animal manure, are available at no cost or at a much lower cost than purchased nitrogen. In addition, in certain areas nitrogen is currently applied at rates which exceed crop uptake rates, usually due to an overabundance of available nutrients from animal waste. Small reductions in passive fertilization in these areas is not likely to have any consequence to fertilizer application. The combination of these factors suggests that the cost associated with compensating for reductions in passive fertilization is relatively minor.

Information on the effects of changes in passive nitrogen deposition on forestlands and other terrestrial ecosystems is very limited. The multiplicity of factors affecting forests, including other potential stressors such as ozone, and limiting factors such as moisture and other nutrients, confound assessments of marginal changes in any one stressor or nutrient in forest ecosystems. However, reductions in deposition of nitrogen could have negative effects on forest and vegetation growth in ecosystems where nitrogen is a limiting factor (EPA, 1993).

On the other hand, there is evidence that forest ecosystems in some areas of the United States are nitrogen saturated (EPA, 1993). Once saturation is reached, adverse effects of additional nitrogen begin to occur such as soil acidification which can lead to leaching of nutrients needed for plant growth and mobilization of harmful elements such as aluminum. Increased soil acidification is also linked to higher amounts of acidic runoff to streams and lakes and leaching of harmful elements into aquatic ecosystems.

Ultraviolet Light

A reduction of tropospheric ozone is likely to increase the penetration of ultraviolet light, specifically UV-b, to ground level. UV-b is an issue of concern because depletion of the stratospheric ozone layer (i.e., ozone in the upper atmosphere) due to chlorofluorocarbons and other ozone-depleting chemicals is associated with increased skin cancer and cataract rates. Currently, EPA is not able to adequately quantify these effects for the purpose of valuing benefits for this policy.

Other EPA programs exist to address the risks posed by changes in UV-b associated with changes in total column ozone. As presented in the Stratospheric Ozone RIA (EPA, 1992), stratospheric ozone levels are expected to significantly improve over the next century as the major ozone depleting substances are phased out globally. This expected improvement in stratospheric ozone levels is estimated to reduce the number of nonmelanoma skin cancers (NMSC's) by millions of cases in the U.S. by 2075.

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Extract from Economics Analysis Supporting the "Effluent Limitations Guidelines and New Source Performance Standards for the Construction and Development Category" 69 69 FR 22472-22483, April 26, 2004.

The Summary of the rule as it appeared in the Federal Register appears below:

SUMMARY: On June 24, 2002, EPA published a proposal that contained several options for the control of storm water discharges from construction sites, including effluent limitations guidelines and new source performance standards. We have selected the option in that proposal that continues to rely on the range of existing programs, regulations, and initiatives at the Federal, State, and local level for the control of storm water discharges from construction sites rather than a new national effluent guideline or other new rule. EPA determined that uniform national technology-based standards are not the most effective way to address storm water discharges from construction sites at this time. Instead, EPA believes that it is better at this time to rely on the existing National Pollutant Discharge Elimination System (NPDES) storm water program, which requires permit coverage for discharges associated with construction activity disturbing at least one acre of land, and also requires municipalities to reduce their stormwater discharges of pollutants to the maximum extent practicable, which can include implementation of tailored local programs to reduce pollutant discharges from construction sites.

Links to the full text of the Economics Analysis (EPA-821-R-02-008) supporting the rule can be found at:
http://www.epa.gov/waterscience/guide/construction/econ/final.htm

Chapter 7, which discusses "Water Quality Benefits" is extracted and inserted below.

CHAPTER SEVEN WATER QUALITY BENEFITS

7.1 NWPCAM ANALYSIS METHODOLOGY

7.1.1 Description of the NWPCAM Model

The National Water Pollution Control Assessment Model (NWPCAM) is a national surface-water quality model that simulates water quality improvements and economic benefits that result from water pollution control policies. NWPCAM is designed to characterize water quality for the nation's network of rivers, streams, and lakes. NWPCAM incorporates a water quality model into a system designed for conducting national policy simulations and benefits assessments. NWPCAM is able to translate spatially varying water quality changes into willingness-to-pay values that reflect the value that individuals place on water quality

improvements. In this way, NWPCAM is capable of deriving economic benefits estimates for a wide variety of water pollution control policies.

NWPCAM's national-scale framework allows hydraulic transport, routing, and connectivity of surface waters to be simulated in the 48 contiguous states. The model can be used to characterize source loadings (e.g., point sources) under a number of alternative policy scenarios (e.g., loadings with controls). These loadings are processed through the NWPCAM water quality modeling system to estimate instream pollutant concentrations on a detailed spatial scale and to estimate policy-induced changes in water quality. The model incorporates routines to translate estimated concentrations into a six-parameter water quality index (WQI6) and an overall use support determination that provide composite measures of overall water quality. The composite measures allow for the calculation of economic benefits associated with the estimated water quality improvements. NWPCAM can be used to assess both the water quality impacts and the social welfare implications of alternative policy scenarios.

NWPCAM 2.1 uses the Reach File 3 (RF3) database routing and connectivity information to assign hydrologic sequencing numbers to each RF3 reach. The RF3 network includes 1,817,988 reaches totaling 2,655,437 miles within the contiguous 48 states. A subset of this network, including only streams greater than 10 miles in length and the small streams connecting them, was extracted for this analysis. The subset, Reach File 3 Lite (RF3Lite) database, capitalizes on the information in the RF3 database while limiting the computational burden of coping with the full network. The RF3Lite network includes 575,991 reaches totaling 835,312 miles, or approximately one-third of the RF3 network. NWPCAM 2.1 includes instream routing routines to connect point source and nonpoint source loads from the RF3 network to RF3Lite. These routines rely primarily on first-order kinetics, using RF3 time of travel estimates to model processes occurring outside of the RF3Lite network.

NWPCAM 2.1 simulates 11 water quality parameters:

• Biochemical oxygen demand (BOD)

• Total organic nitrogen (TON)

- Ammonia (NH_3)
- Nitrate-N and Nitrite-N (NO_x)
- Total organic phosphorous (TOP)
- Ortho-phosphate (PO_4)
- Algae chlorophyll (CHLA)
- Dissolved oxygen (DO)
- Chlorides (Cl)
- Total suspended solids (TSS)
- Fecal coliform bacteria (FEC)

The original water quality index included nine indicators of water quality (McClelland, 1974). BOD, DO, FEC, NO_x, PO_4 and TSS are used in the WQI6. McClelland (1974) used turbidity in her assessment rather than TSS. To incorporate TSS, a regression equation was used to convert the original graph of water quality against turbidity into a graph of water quality against TSS. The water quality index is multiplicative so the weights given to all of the components must sum to one. Thus, the weights for the WQI6 components were revised to sum to one based on their weights in the original water quality index.

EPA focused on sediment loads from construction sites. Site experience was generalized using appropriate adaptations to different weather, slope, and soil conditions in different regions of the country to estimate changes in sediment loads. Details of this analysis may be found in the Development Document (U.S. EPA, 2004, Chapter Eight). The analysis generated an estimate of the change in total suspended solids for 1,644 watersheds. To avoid double-counting, a portion of the background non-point source TSS

loads were removed from the model for each land cover cell devoted to construction. National baseline TSS loads from construction sites were estimated to be 5.7 million metric tons per year. Option 4 is estimated to reduce this total loading to 4.9 million metric tons per year.

NWPCAM 2.1 uses this loading data to generate input and output files for thousands of Eutro-Water Quality Analysis Simulation Program, Version 5 (WASP5) model runs. Eutro-WASP5 calculates the decay and dispersion dynamics of the water quality indicators of WQI6 by modeling the mixing, exchange, chemical, and biological processes occurring as the effluent flows through the surface-water network. Many characteristics of the waterways and their environment contribute to the process models.

7.1.2 Valuation of Water Quality Changes

The correct benefit measure to compare with social costs is the change in producer and consumer surplus ensuing from a change in environmental quality. One way to measure this quantity is to elicit individuals' willingness to pay for the change. Most benefit assessments in the soil conservation context take an alternative approach using the costs of avoiding the consequences of the environmental harm as a proxy for willingness to pay. This was the approach taken for the benefits assessment of the C&D options at proposal. For assessing the Final Action, however, EPA adopted an alternative survey-based approach.

To value predicted reductions in the pollution of rivers and streams, NWPCAM applies estimates of Americans' willingness to pay for improvements in water quality. The foundation of these estimates is a contingent valuation survey developed by Richard Carson and Robert Mitchell (Carson and Mitchell, 1993). This survey, which is national in scope, characterizes households' annual willingness to pay to improve freshwater resources from baseline conditions to conditions that better enable beneficial uses such as boating, fishing, and swimming. EPA uses the Carson and Mitchell research in two separate analyses:

- First, EPA develops benefits based on the public's willingness to pay for improvements in water quality that allow discrete movement to higher levels on a "ladder" of potential water uses.
- Second, EPA develops benefits based on a continuous water quality index, WQI6.

In the following section, we discuss these two methods in greater detail. The resulting economic benefit estimates are discussed in Section 7.2, Benefits Assessment Results.

7.1.2.1 Water Quality Ladder Approach

EPA's first approach to relating surface-water conditions to the ability of a body of water to support a particular designated use is based on a water quality ladder. The ability of a water body to support beneficial uses at each step of the water quality ladder is defined by measures of DO, BOD, TSS, and FEC. In order for a body of water to be considered boatable, fishable, or swimmable, it must satisfy the minimum numeric criteria consistent with that use for all modeled parameters. These minimum conditions are the same for all geographic areas. NWPCAM classifies each segment of each modeled river or stream as swimmable, fishable, boatable, or non-supportive of any of these uses. The model calculates the total stream-miles that support each designated use under each set of loadings conditions (i.e., baseline conditions or conditions following implementation of the regulations).

The contingent valuation survey on which this analysis relies examined households' willingness to pay to maintain or achieve specified levels of water quality in freshwater lakes, rivers, and streams throughout the United States (Carson and Mitchell, 1993). Respondents were presented with the water quality ladder and asked to state how much they would be willing to pay to maintain or achieve various levels of water quality throughout the country.

Applying the willingness-to-pay estimates obtained from the Carson and Mitchell study to analyze the benefits of regulations requires consideration of how households' willingness to pay for water quality improvements is likely to vary with the extent and location of the resources affected. People are likely to place greater value on improving the quality of water resources that are located nearer to them because less time and expense is typically required to reach nearer resources; as a result, these resources generally provide lower cost and more frequent opportunities for recreation and enjoyment. To reflect this consideration, the analysis separately calculates the benefits of in-state and out-of-state

improvements, assuming that households will allocate two-thirds of their willingness-to-pay values to the improvement of in-state waters. In addition, the analysis takes into account the number of stream-miles that improve from one use class to another by scaling household willingness to pay for a given improvement by the proportion of total stream-miles that are projected to make the improvement.

7.1.2.2 Water Quality Index Approach

A key limitation of the water quality ladder approach is that it only values changes in water quality to the extent that they lead to changes in beneficial-use attainment. As a result, the approach may attribute all of the benefits that occur at the thresholds between beneficial use categories to relatively small changes in water quality indicators, while failing to capture the benefits of large changes that occur without crossing the thresholds. In assessing a change in a large number of sources, changes that happen to push a reach over the threshold will balance out those that do not, and the statistical outcome would be a fair measure of willingness to pay. This rule, however, affects relatively few miles of water ways. The limited sample size opens the door for chance changes in a few places to drive the results higher or lower. Furthermore, the use classification is determined by the worst individual water quality parameter. For example, if TSS achieves the boatable criterion but fecal coliform does not, the reach would still be classified as non-boatable. The water quality index approach is designed to address these concerns.

Under the water quality index approach, NWPCAM calculates WQI6. EPA relies on a willingness-to-pay function derived by Carson and Mitchell using their survey results. This equation specifies household willingness to pay for improved water quality as a function of WQI6, household income, household participation in water-based recreation, and respondents' attitudes toward environmental protection. EPA estimates changes in index values using NWPCAM and applies the willingness-to-pay function to estimate benefits. Based on this approach, EPA is able to assess the value of improvements in water quality along the continuous 0 to 100 point scale. As with the water quality ladder approach, the calculation of benefits is developed by state and takes into account differences in willingness to pay for local

and non-local water quality improvements (i.e., it assumes households will allocate two-thirds of their willingness to pay for improvements to in-state waters).

Results of the two monetization analyses are presented in Section 7.2. See the Environmental and Economic Benefit Analysis for the concentrated animal feeding operations ELG for a more detailed description of the two valuation approaches and their application (U.S. EPA, 2002, Section 4.6).

7.1.3 Nonquantified Categories of Benefits

Commenters on the proposed C&D regulation cited a number of categories of benefits that were not included in the assessment of the rule. Inadequate data and modeling constraints prevented quantification or monetization of any categories beyond the sediment effects considered in the NWPCAM analysis discussed above. Nevertheless, other effects of the Final Action will generate benefits to society. To organize its discussion of non-quantified benefit categories, EPA considers the path stormwater, sediment, and related pollutants take from a building site to their final deposition. Along this path, excess sediment and water creates costs to society in terms of increased maintenance costs, disamenities, and outright damage. Table 7-1 summarizes the ways in which practices required by this regulation may address categories of social impacts from fugitive sediment. The depth of analysis column indicates whether the effect has been monetized through the NWPCAM process, quantified, or is discussed qualitatively. Given the format of the Mitchell-Carson willingness-to-pay survey, it is difficult to know what respondents were valuing in terms of specific environmental changes. Those identified as monetized in Table 7-1 are categories that individuals may have considered in their responses to the survey.

7.2 BENEFITS ASSESSMENT RESULTS

EPA's purpose in considering Options 2 and 4 is to benefit the nation by improving water quality and the environment. These benefits can be measured in

economic terms and balanced against the costs of implementing the incremental regulatory options. The preceding section described many categories of

Table 7-1.	**Framework of Benefit Categories and Depth of Analysis**
Built Environment	
Create site amenities such as water features	Qualitative
Encourage development of "green" v. "brown" sites	Qualitative
Reduce street dredging costs	Qualitative
Reduce clogging of stormwater conveyance systems - ditches and culverts	Qualitative
Reduce impacts of construction on stormwater treatment practices	Qualitative
Temporary Sediment Deposition	
Reduce overland erosion	Qualitative
Reduce effect of excess sediment on stream benthos and habitat	Quantified
Long-Term Sediment Deposition - Sediment Sinks	
Reduce filling of wetlands and related habitat effects	Qualitative
Reduce loss of reservoir capacity	Qualitative
Reduce filling of navigational channels	Qualitative
Reduce sedimentation of shellfish beds	Qualitative
Suspended Sediment in the Water Column	
Improve water quality for recreational use, particularly fishing	Monetized
Reduced costs to treat drinking water	Monetized
Reduced costs to treat cooling/process water	Monetized
Improve the aesthetic appearance of rivers and lakes	Monetized
Nutrients in the Water Column - Eutrophication	
Reduce excess nutrients that cause lake and estuary habitat change	Qualitative
Improve water clarity and reduce associated loss in property values	Monetized
Reduce the frequency of anaerobic events and other fishery impacts	Qualitative

Hydrological Changes	
Reduce the need for stream restoration by maintaining natural flows	Qualitative
Reduce damage to bridges and culverts from peak flows	Qualitative
Reduce the impact on thermal conditions	Qualitative
Non-Use Benefits	
Bequest, existence, and similar non-use aspects of water quality.	Monetized

benefits that EPA believes would likely be generated by these options. It also described the methodologies EPA developed to measure the benefits of the options. This chapter summarizes the results of that analysis. The first section draws on the Environmental Assessment to show the changes in sediment loads that indicate the environmental effects of the regulation. The second section describes the results of applying these environmental changes to the NWPCAM benefit estimation model described in Section 7.1.

7.2.1 Environmental Assessment Results

The Environmental Assessment used a model watershed approach to estimate TSS in the baseline condition and under the alternative options. TSS is a measure indicating the level of sediment in the water. Sediment is a good indicator of the regulation's effectiveness both for sedimentation and turbidity effects and because nutrients, metals, and organic compounds enter the environment attached to sediment particles. Table 7-2 shows the estimated difference between sediment tonnage released under the baseline and that released under Option 4.

Option 4 reduces the nationwide total solids loads measured at the land cover cell level (i.e., at the construction site) from 5.7 million metric tons per year to 4.9 million metric tons per year (Miles and Bondelid, 2004). NWPCAM, the water quality model used for this assessment, is based on RF3Lite. Only about 61 percent of TSS generated at construction sites is estimated to reach RF3Lite waters where water quality benefits are measured. The option would generate a 15 percent reduction in the TSS load generated by construction activities. See the Technical

Development Document (EPA, 2004) for a more extensive explanation of how the changes in loads were derived.

Table 7-2. Benefit Assessment Summary Land Cover Cell Load		Reach File 3 Lite Load	
Option	**(thousand metric tons/year)**	**(thousand metric tons/year)**	**Reduction from Baseline**
3 (Baseline)	5,705	3,454	
4	4,851	2,938	14.9%

Source: Miles and Bondelid, 2003.

7.2.2 Benefits Assessment Results

As discussed in Section 7.1, the sediment loadings drive the NWPCAM/Mitchell-Carson benefit analysis. Table 7-3 shows the monetized benefit estimates using the water quality ladder and water quality index approaches. These figures represent the present value of benefits of Option 4 derived from one year's construction activity. As construction sites are quite short-lived, all of the benefits occur within one year so discounting for the time value of money is moot. This formulation places the benefits in the same terms as the costs developed in Chapter Five.

Table 7-3. Benefit Assessment Summary—Differences from Baseline Water Quality Ladder Category	**Water Quality Ladder Approach ($ Million, 2000)**	**Water Quality Index Category**	**Water Quality Index Approach ($ Million, 2000)**
Boatable	$ 8.05	<26	$ 0.03
Fishable	$ 14.83	26-70	$ 7.34
Swimmable	$ 4.11	>70	$ 7.10
Total	$ 26.99	Total	$ 14.47

Source: Miles and Bondelid, 2004.

While the water quality index approach includes improvements in many more miles of waterways (9,303 miles) than the water quality ladder approach (803 miles), the improvements generate a smaller total value. Each change in water quality ladder category captures all of the value of the shift from one category to another. Each improvement evaluated under the water quality index generates only a small increment in willingness to pay.

As discussed in Section 7.1, these benefit estimates represent only the fraction of total benefits that can be monetized. Many other results of the regulation will also improve social welfare but could not be reasonably quantified from the available information.

7.3 REFERENCES

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Appendix A: Summaries of Regulatory Text and Extracts from Supplementary Text for Significant Final Rules 1996-2003 with Ecological Concerns

Significant Final Rules in FY 1996

Acid Rain Program: Nitrogen Oxides Control Regulation 61 FR 67112

SUMMARY: This action promulgates standards for the second phase of the Nitrogen Oxides Reduction Program under Title IV of the Clean Air Act (``CAA'' or ``the Act'') by establishing nitrogen oxides (NOX) emission limitations for certain coal-fired electric utility units and revising NOX emission limitations for others as specified in section 407(b)(2) of the Act. The emission limitations will reduce the serious adverse effects of NOX emissions on human health, visibility, ecosystems, and materials.

Land Disposal Restrictions Phase III; Final Rule and Partial Withdrawal and Amendment of Final Rule 61 FR 15566

SUMMARY: EPA is promulgating treatment standards for hazardous wastes from the production of carbamate pesticides and from primary aluminum production under its Land Disposal Restrictions (LDR) program. The purpose of the LDR program, authorized by the Resource Conservation and Recovery Act (RCRA), is to minimize short- and long-term threats to human health and the environment due to land disposal of hazardous wastes.

The Agency is also amending the treatment standards for hazardous wastes that exhibit the characteristic of reactivity. The rule also begins the process of amending existing treatment standards for wastewaters which are hazardous because they display the characteristic of ignitability, corrosivity, reactivity, or toxicity. These wastes are sometimes treated in lagoons whose ultimate discharge is regulated under the Clean Water Act, and sometimes injected into deepwells which are regulated under the Safe Drinking Water Act. Prior to today's rule, the treatment standard for these wastes required only removal of the characteristic property. Today's revised treatment standards require treatment, not only to remove the characteristic, but also to treat any underlying hazardous constituents which may be present in the wastes. Therefore, these revised treatment standards will minimize threats from exposure to hazardous constituents which may potentially migrate from these lagoons or wells.

Finally, EPA is codifying as a rule its existing Enforcement Policy that combustion of inorganic wastes is an impermissible form of treatment because hazardous constituents are being diluted rather than effectively treated.

Discussion of non-human health benefits of the rule: The Agency proposed to regulate fluoride in K088. While fluoride is not a ``hazardous constituent'', i.e., listed in Appendix VIII of part 261, it is present in very high concentrations in K088 and is capable of causing substantial harm in the form of groundwater degradation, adverse ecological effects and potential adverse human health

effects. The Agency's view thus is that, unless fluoride in this waste is treated, the legal standard in section 3004(m) would not be satisfied

Standards of Performance for New Stationary Sources and Guidelines for Control of Existing Sources: Municipal Solid Waste Landfills 61 FR 9905

SUMMARY: This action adds subparts WWW and Cc to 40 CFR part 60 by promulgating standards of performance for new municipal solid waste landfills and emission guidelines for existing municipal solid waste landfills. This action also adds the source category ``municipal solid waste landfills'' to the priority list in 40 CFR Part 60, Sec. 60.16, for regulation under section 111 of the Clean Air Act. These standards and emission guidelines implement section 111 of the Clean Air Act and are based on the Administrator's determination that municipal solid waste landfills cause, or contribute significantly to, air pollution that may reasonably be anticipated to endanger public health or welfare. The emissions of concern are non-methane organic compounds (NMOC) and methane. NMOC include volatile organic compounds (VOC), hazardous air pollutants (HAPs), and odorous compounds. VOC emissions contribute to ozone formation which can result in adverse effects to human health and vegetation. Ozone can penetrate into different regions of the respiratory tract and be absorbed through the respiratory system. The health effects of exposure to HAPs can include cancer, respiratory irritation, and damage to the nervous system. Methane emissions contribute to global climate change and can result in fires or explosions when they accumulate in structures on or off the landfill site. The intended effect of the standards and guidelines is to require certain municipal solid waste landfills to control emissions to the level achievable by the best demonstrated system of continuous emission reduction, considering costs, nonair quality health, and environmental and energy impacts.

Regulation of Fuels and Fuel Additives: Certification Standards for Deposit Control Gasoline Additives; Final Rule 61 FR 31668

SUMMARY: This action establishes a certification program for detergent additives used to control the formation of port fuel injector deposits (PFID) and intake valve deposits (IVD) in gasoline engines. In accordance with Clean Air Act section 211(l), an interim detergent program has been in effect since January 1, 1995, requiring the use of detergents in virtually all gasoline used in the U.S. This final rule contains standardized test procedures and performance standards to ensure that such detergent gasoline will provide an effective level of protection against PFID and IVD. The regulations include a variety of certification options and compliance alternatives, affording cost-effective flexibility to regulated parties. The effective control of deposits in gasoline engine and fuel supply systems has been shown to reduce the emission of nitrogen oxides, hydrocarbons, and carbon monoxide in engine exhaust, while enhancing fuel economy. Accordingly, the intent of the detergent certification program is to help achieve

the primary public health and environmental protection goals of the Clean Air Act.

Significant Final Rules in FY1997

Control of Emissions of Air Pollution From Nonroad Diesel Engines 62 FR 54694

SUMMARY: The new standards and related provisions contained in this final rule will result in significant progress throughout the country in protecting public health and the environment. In this action, EPA is adopting a new emission standard and related provisions for diesel heavy-duty engines (HDEs) intended for highway operation, beginning with the 2004 model year. The new standard represents a large reduction (approximately 50 percent) in emission of oxides of nitrogen (NOx), as well as reductions in hydrocarbons (HC) from diesel trucks and buses. The reduction in NOx will also result in significant reductions in secondary nitrate particulate matter (PM) in areas where levels of nitrate PM are high. For diesel HDEs, EPA is also finalizing changes to the existing averaging, banking, and trading program that provide additional flexibility for manufacturers in complying with the stringent new standards. EPA is also adopting several provisions to increase the durability of emission controls, help ensure proper levels of maintenance, and prevent tampering, including during engine rebuilding. The resulting emission reductions will translate into significant, long-term improvements in air quality in many areas of the U.S. This will provide much-needed assistance to states and regions facing ozone and particulate air quality problems that are causing a range of adverse health effects for their citizens, especially in terms of respiratory impairment and related illnesses. Although EPA proposed new standards and related averaging, banking, and trading provisions for otto-cycle HDEs (e.g., gasoline-fueled engines), EPA is not taking final action for that category of engines at this time. EPA received several comments urging the Agency to adopt more stringent control measures for these engines than those proposed in the NPRM (June 27, 1996). EPA continues to evaluate the comments received regarding otto-cycle engines and plans to issue a Supplemental Notice of Proposed Rulemaking to address otto-cycle engines specifically.

Discussion of ecological benefits from section VI.C. of the rule: "In addition to the benefits of reducing ozone within and transported into urban ozone nonattainment areas, the NO_X reductions from the proposed nonroad engine standards are expected to have beneficial impacts with respect to crop damage, secondary particulate, acid deposition, eutrophication, visibility, and forests, as described earlier. Because of the difficulty of quantifying the monetary value of these societal benefits, the cost-effectiveness values presented do not assign any numerical value to these additional benefits. However, based on an analysis of existing studies that have estimated the value of such benefits in the past, the Agency believes that the actual monetary value of the multiple environmental and public health benefits that would be produced by large NO_X reductions similar to

those projected under this proposal will likely be greater than the estimated compliance costs. EPA requests comment on including these benefits in an estimate of the cost-effectiveness of the proposed standards."

Hospital/Medical/Infectious Waste Incinerators 62 FR 48348

SUMMARY: This action promulgates new source performance standards (NSPS or standards) and emission guidelines (EG or guidelines) to reduce air emissions from hospital/medical/infectious waste incinerator(s) (HMIWI) by adding subpart Ec, standards of performance for new HMIWI, and subpart Ce, emission guidelines for existing HMIWI, to 40 CFR part 60. The standards and guidelines implement sections 111 and 129 of the Clean Air Act (CAA) as amended in 1990. The standards and guidelines apply to units whose primary purpose is the combustion of hospital waste and/or medical/infectious waste. Sources are required to achieve emission levels reflecting the maximum degree of reduction in emissions of air pollutants that the Administrator has determined is achievable, taking into consideration the cost of achieving such emission reduction, any nonair-quality health and environmental impacts, and energy requirements. The promulgated standards and guidelines establish emission limits for particulate matter (PM), opacity, sulfur dioxide (SO2), hydrogen chloride (HCl), oxides of nitrogen (NOX), carbon monoxide (CO), lead (Pb), cadmium (Cd), mercury (Hg), dioxins and dibenzofurans (dioxins/furans), and fugitive ash emissions. Some of the pollutants being regulated are considered to be carcinogens and at sufficient concentrations can cause toxic effects following exposure. The standards and guidelines also establish requirements for HMIWI operator training/qualification, waste management plans, and testing/monitoring of pollutants and operating parameters. Additionally, the guidelines for existing HMIWI contain equipment inspection requirements and the standards for new HMIWI include siting requirements.

Discussion of non-human health benefits of the rule: "The regulatory impact assessment document has been updated for the final rule and is entitled ``Hospital/Medical/Infectious Waste Incinerators: Background Information for Promulgated Standards and Guidelines--Regulatory Impact Analysis for New and Existing Facilities" (EPA-453/R-97-009b). Estimates of the costs and benefits of the various regulatory options considered are discussed in the revised regulatory impact analysis document and in Appendices A and B of ``Hospital/Medical/Infectious Waste Incinerators: Background Information for Promulgated Standards and Guidelines--Summary of Public Comments and Responses" (EPA-453/R-97-006b).
"... Air quality benefits resulting from the air quality improvements resulting from this regulation include a reduction in adverse health effects associated with inhalation of the above pollutants as well as improved welfare effects such as improved visibility and crop yields. While the Agency believes that the health and environmental benefits of this rule are quite significant, the EPA is not currently able to quantitatively evaluate all human and environmental benefits

associated with the rule's air quality improvements, and is even more limited in its ability to assign monetary values to these benefit categories. Categories that are not evaluated include several health and welfare endpoints (categories), as well as entire pollutant categories. Consequently, the discussion of benefits included in the Regulatory Impact Analysis and summarized here is primarily qualitative.

However, monetized benefits were calculated for PM emissions reductions. These benefits were estimated using a valuation of $6075/ton, based on analyses of PM emissions reductions benefits from other rules that are discussed in the EPA document, ``Benefit-Cost Analysis of Selected NSPS for Particulate Matter.'' Total PM emissions reduction benefits from this rule are estimated to range from $5.5 million under Scenario B to $5.8 million under Scenario C. Thus net monetized costs (after subtracting out monetized benefits) are estimated to range from $65 million under Scenario B to $140 million under Scenario C. Although the monetized benefits associated with PM emission reductions are compared to the estimated annualized emission control costs of the regulation, EPA notes that, because most categories of emissions reductions cannot be monetized, the monetized benefits and therefore the net benefits are understated (in this case annualized costs exceed the monetized benefits so net costs are overstated) for the regulation. A qualitative discussion of the pollutants that do not have a monetary benefit value shows the significance of other benefits achieved by the rule. Emission reductions of Cd, Pb, HCl, and Hg are expected to occur as a result of the HMIWI rule. Health effects associated with exposures to Cd and Pb include probable carcinogenic effects. Respiratory effects are associated with exposure to Cd, HCl, and Hg. The HAP emitted from HMIWI facilities have also been associated with effects on the central nervous system, neurological system, gastrointestinal system, mucous membranes, and kidneys. Reduction in emission of dioxin/furan are expected as a result of the HMIWI rule. Exposure to dioxin/furan has been linked to reproductive and developmental effects, changes in hormone levels, and chloracne. Toxic Equivalent Quantity, or TEQ, has been developed as a measure of the toxicity of dioxin/furan. The TEQ measures the more chlorinated compounds of dioxin/furan and thus provides a better indicator of the part of dioxin/furan that has been linked to the toxic effects associated with dioxin/furan. Unfortunately, quantitative relationships between the toxic effects and exposure to dioxin/furan have not been developed. Therefore, quantitative estimates of the health effects of dioxin/furan emission reductions are not estimated. Emission reductions are also anticipated for criteria air pollutants. The health effects associated with exposure to PM include premature mortality as well as morbidity. The morbidity effects of PM exposure have been measured in terms of increased hospital and emergency room visits, days of restricted activity or work loss, increased respiratory symptoms, and reductions in lung function. The welfare effects of PM exposure include increased soiling and visibility degradation. Sulfur dioxide has been associated with respiratory symptoms and pulmonary function changes in exercising asthmatics and may also be associated with respiratory symptoms in nonasthmatics. In addition to the effects on human health, SO2 has also been linked to adverse welfare effects, such as materials damage, visibility

degradation, and crop and forestry damage. Carbon monoxide affects the oxygen-carrying capacity of hemoglobin and, at current ambient concentrations, has been related to adverse health effects among persons with cardiovascular and chronic respiratory disease. Both congestive heart failure and angina pectoris have been related to CO exposure. Nitrogen oxides have also been shown to have an adverse impact on both human health and welfare. The effects associated with NOx include respiratory illness, damages to materials, crops, and forests, and visibility degradation."

From the 1998 OMB Report to Congress on the Costs and Benefits of Federal Regulations: Table 9 "EPA states that it cannot quantify or monetize many of the benefits, such as the reduction in the emission of hazardous air pollutants, which include cadmium, hydrogen chloride, lead, mercury, and dioxin/furan.

Land Disposal Restrictions - Phase IV: Treatment Standards for Metal Wastes and Mineral Processing wastes; Mineral Processing Secondary Materials and Bevill Exclusion Issues 62 FR 25998

SUMMARY: The Agency is finalizing treatment standards for hazardous wastes generated from wood preserving operations, and is making a conforming amendment to the standard for wastes from production of chlorinated aliphatics which carry the F024 hazardous waste code. These treatment standards will minimize threats to human health and the environment posed by these wastes. In addition, this final rule revises the land disposal restrictions (LDR) program to significantly reduce paperwork requirements by 1.6 million hours. This rule also finalizes both the decision to employ polymerization as an alternative method of treatment for certain ignitable wastes as well as the decision not to ban certain wastes from biological treatment because there is no need to classify these wastes as ``nonamenable.'' It also clarifies an exception from LDR requirements for de minimis amounts of characteristic wastewaters. Finally, this rule excludes processed circuit boards and scrap metal from RCRA regulation which is intended to promote the goal of safe recycling.

Benefits Discussion from the rule: " the Agency has concluded that LDR rules like today's rule may produce benefits in the area of ecological risk reduction and reduced natural resource damage. EPA has not developed a quantitative assessment of these benefits categories because of budgetary and data limitations."..

NAAQS: Ozone (Review) 62 FR 38856

SUMMARY: This document describes EPA's decision to revise the national ambient air quality standards (NAAQS) for ozone (O3) based on its review of the available scientific evidence linking exposures to ambient O3 to adverse health and welfare effects at levels allowed by the current O3 standards. The current 1-hour primary standard is replaced by an 8-hour standard at a level of 0.08 parts

per million (ppm) with a form based on the 3-year average of the annual fourth-highest daily maximum 8-hour average O3 concentrations measured at each monitor within an area. The new primary standard will provide increased protection to the public, especially children and other at-risk populations, against a wide range of O3-induced health effects, including decreased lung function, primarily in children active outdoors; increased respiratory symptoms, particularly in highly sensitive individuals; hospital admissions and emergency room visits for respiratory causes, among children and adults with pre-existing respiratory disease such as asthma; inflammation of the lung, and possible long-term damage to the lungs. The current 1-hour secondary standard is replaced by an 8-hour standard identical to the new primary standard. The new secondary standard will provide increased protection to the public welfare against O3-induced effects on vegetation, such as agricultural crop loss, damage to forests and ecosystems, and visible foliar injury to sensitive species.

Benefits discussion in the rule: Background: "A secondary standard, as defined in section 109(b)(2), must ``specify a level of air quality the attainment and maintenance of which in the judgment of the Administrator, based on [the] criteria, [are] requisite to protect the public welfare from any known or anticipated adverse effects associated with the presence of [the] pollutant in the ambient air." Welfare effects as defined in section 302(h) (42 U.S.C. 7602(h)) include, but are not limited to, ``effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility, and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being."

...to remedy the lack of air quality data in rural and remote areas of commercial or ecological importance for vegetation, the Administrator reiterates her intention, expressed in the proposal, to expand the rural O_3 monitoring network. The EPA will propose revised O_3 air quality surveillance requirements (40 CFR part 58) at a later date. The EPA is exploring opportunities to work with other Federal agencies to develop a coordinated and long-term rural monitoring network.

NAAQS: Particulate Matter (Review) 62 FR 38652

SUMMARY: This document describes EPA's decision to revise the national ambient air quality standards (NAAQS) for particulate matter (PM) based on its review of the available scientific evidence linking exposures to ambient PM to adverse health and welfare effects at levels allowed by the current PM standards. The current primary PM standards are revised in several respects: Two new PM2.5 standards are added, set at 15 g/m3 , based on the 3-year average of annual arithmetic mean PM2.5 concentrations from single or multiple community-oriented monitors, and 65 g/m 3 , based on the 3-year average of the 98th percentile of 24-hour PM2.5 concentrations at each population-oriented monitor within an area; and the current 24-hour PM10 standard is revised to be based on

the 99th percentile of 24-hour PM10 concentrations at each monitor within an area. The new suite of primary standards will provide increased protection against a wide range of PM-related health effects, including premature mortality and increased hospital admissions and emergency room visits, primarily in the elderly and individuals with cardiopulmonary disease; increased respiratory symptoms and disease, in children and individuals with cardiopulmonary disease such as asthma; decreased lung function, particularly in children and individuals with asthma; and alterations in lung tissue and structure and in respiratory tract defense mechanisms. The current secondary standards are revised by making them identical in all respects to the new suite of primary standards. The new secondary standards, in conjunction with a regional haze program, will provide appropriate protection against PM-related public welfare effects including soiling, material damage, and visibility impairment. In conjunction with the new PM2.5 standards, a new reference method has been specified for monitoring PM as PM2.5.

Discussion of non-human health benefits from the rule: *"The Criteria Document and Staff Paper examined the effects of PM on such aspects of public welfare as visibility, materials damage, and soiling. The following discussion of the rationale for revising the secondary standards for PM focuses on those considerations most influential in the Administrator's decision.*
A. Need for Revision of the Current Secondary Standards 1. Visibility impairment. This unit of the document presents the Administrator's decision to address the welfare effects of PM on visibility by setting secondary standards identical to the suite of PM2.5 primary standards, in conjunction with the establishment of a regional haze program under section 169A of the Act.
(Congress adopted section 169A of the Act because of concern that the NAAQS and Prevention of Significant Deterioration programs might not provide adequate visibility protection nationally, particularly for ``areas of great scenic importance." See H.R. Rep. No. 95-294,at 203-205 (1977)]. *In the Administrator's judgment, this approach is the most effective way to address visibility impairment given the regional variations in concentrations of non-anthropogenic PM as well as other regional factors that affect visibility, such as humidity. By augmenting the protection provided by secondary standards set identical to the suite of PM2.5 primary standards with a regional haze program, the Administrator believes that an appropriate degree of visibility protection can be achieved in the various regions of the country.--*

In coming to this decision, the Administrator took into account several factors, including: The pertinent scientific and technical information in the Criteria Document and Staff Paper, difficulties inherent in attempting to establish national secondary standards to address visibility impairment, the degree of visibility improvement expected through attainment of secondary standards equivalent to the suite of PM2.5 primary standards, the effectiveness of addressing the welfare effects of PM on visibility through the combination of a regional haze program and secondary standards for PM2.5 equivalent to the suite of primary standards, and comments received during the public comment period. The Administrator's consideration of each of these factors is discussed below in

this unit. The Administrator first concluded, based on information presented and referenced in the Criteria Document and Staff Paper, that particulate matter can and does produce adverse effects on visibility in various locations, depending on the PM concentrations involved and other factors discussed below. It has been demonstrated that impairment of visibility is an important effect of PM on public welfare, and that it is experienced throughout the United States, in multi-state regions, urban areas, and remote mandatory Class I Federal areas (There are 156 mandatory Class I Federal areas protected by the visibility provisions in sections 169A and 169B of the Act. These areas are defined in section 162 of the Act as those national parks exceeding 6,000 acres, wilderness areas and memorial parks exceeding 5,000 acres, and all international parks which were in existence on August 7, 1977. alike. Visibility is an important welfare effect because it has direct significance to people's enjoyment of daily activities in all parts of the country. Individuals value good visibility for the well-being it provides them directly, both where they live and work, and in places where they enjoy recreational opportunities. Visibility is highly valued in significant natural areas, such as national parks and wilderness areas, because of the special emphasis given to protecting these lands now and for future generations. The Criteria Document cites many studies designed to quantify the benefits associated with improvements in visibility.

The Administrator considered information from the Staff Paper and Criteria Document regarding the effect of the composition of particulate matter on visibility. Visibility conditions are determined by the scattering and absorption of light by particles and gases, from both natural and anthropogenic sources. Visibility can be described in terms of visual range, light extinction, or deciview (Visual range can be defined as the maximum distance at which one can identify a black object against the horizon sky. It is typically described in miles or kilometers. Light extinction is the sum of light scattering and absorption by particles and gases in the atmosphere. It is typically expressed in terms of inverse megameters, with larger values representing poorer visibility. The deciview metric describes perceived visual changes in a linear fashion over its entire range, analogous to the decibel scale for sound. A deciview of 0 represents pristine conditions. Under many scenic conditions, a change of 1 deciview is considered perceptible by the average person.). The classes of fine particles principally responsible for visibility impairment are s*ulfates, nitrates, organic matter, elemental carbon (soot), and soil dust. Fine particles are more efficient per unit mass at scattering light than coarse particles. The scattering efficiency of certain classes of fine particles, such as sulfates, nitrates, and some organics, increases as relative humidity rises because these particles can absorb water and grow to sizes comparable to the wavelength of visible light. In addition to limiting the distance that one can see, the scattering and absorption of light caused by air pollution can also degrade the color, clarity, and contrast of scenes. Light extinction is the sum of light scattering and absorption by particles and gases in the atmosphere. It is typically expressed in terms of inverse megameters (Mm), with larger values representing poorer visibility. The deciview metric describes perceived visual changes in a linear fashion over its entire range, analogous to*

the decibel scale for sound. A deciview of 0 represents pristine conditions. Under many scenic conditions, a change of 1 deciview is considered perceptible by the average person.

The Administrator next considered what would be an appropriate level for a secondary standard to address adverse effects of particulate matter on visibility. The determination of a single national level is complicated by regional differences in visibility impairment due to several factors, including background and current levels of PM, composition of particulate matter, and average relative humidity. The Criteria Document and Staff Paper describe estimated background levels of PM and natural light extinction. In the United States, estimated annual mean background levels of PM2.5 are significantly lower in the West than in the East. Based on estimated background fine particle and light extinction levels summarized in Table VIII-2 of the Staff Paper, naturally occurring visual range in the East is approximately 105 to 195 kilometers, whereas in the West it is approximately 190 to 270 kilometers. This significant regional difference in estimated background conditions results from two main factors. First, in the western United States, visibility is more sensitive to an additional 1-2 µg/m of PM2.5in the atmosphere than in the eastern United States. Secondly, light scattering is increased for certain particles (e.g., sulfates, nitrates, and some organics) due to higher average relative humidity in the East.

The combination of naturally occurring and manmade emissions also leads to significant differences in current visibility conditions between the eastern United States, 23-39 kilometers average visual range, and western United States, 55-150 kilometers average visual range. Table VIII-4 of the Staff Paper indicates that the current level of annual average light extinction in several western locations, such as the Colorado Plateau, is about equal to the level of background light extinction, i.e., the level generally regarded as representing the absence of anthropogenic emissions in North America, in the East. This regional difference is due to higher background particle concentrations in the East, a composition of fine particles in the East that, in association with higher eastern humidity levels, is more efficient at light scattering, and significantly lower concentrations of anthropogenic PM in remote western locations as compared with remote eastern sites.

Because of these regional differences, it is the Administrator's judgment that a national secondary standard intended to maintain or improve visibility conditions on the Colorado Plateau or other parts of the West would have to be set at or even below natural background levels in the East, which would effectively require elimination of all eastern anthropogenic emissions. Conversely, a national secondary standard that would achieve an appropriate degree of visibility improvement in the East would permit further degradation in the West. Due to this regional variability in visibility conditions created by differing background fine particle levels, fine particle composition, and humidity effects, the Administrator finds that addressing visibility solely through setting more stringent national secondary standards would not be an appropriate means to protect the public welfare from adverse impacts of PM on visibility in all parts of the country Congress adopted a visibility protection program in section 169A

of the Act because it recognized the impracticability of revising the NAAQS to protect visibility in all areas of the country: ``It would be impracticable to require a major city such as New York or Los Angeles to meet the same visibility standards as the Grand Canyon and Yellowstone Park." See H.R. Rep. No. 95-294 at 205. (1977). (Aside from the problem of regional variability, the Administrator has also determined that the Agency currently lacks sufficient information to establish a level for a national secondary standard that would represent a threshold above which visibility conditions would always be adverse and below which visibility conditions would always be acceptable. Because visibility varies not only with PM concentration, but also with PM composition and humidity levels, attaining even a low concentration of fine particles might or might not provide adequate protection, depending on these factors.

The Administrator next assessed potential visibility improvements (Estimates of annual average visibility improvements assume that, on a percentage basis, the reduction for each fine particle component is equal to the % reduction in the mass of fine particles, and that the overall light extinction efficiency of the fine particle pollutant mix does not change. Further, for the estimates presented here, the reductions in fine mass at monitored locations are assumed to reflect the spatial average concentrations through the viewing distance. (Damberg and Polkowsky, 1996.) that would result from attainment of the new primary standards for PM2.5. The spatially averaged form of the annual standard is well suited to the protection of visibility, which involves effects of PM throughout an extended viewing distance across an urban area. Indeed, as the generally controlling standard focused on reducing urban and regional scale fine particle levels, most of the visibility protection provided by the PM2.5 primary standards would be derived from the annual standard. In many cities having annual mean PM2.5 concentrations exceeding 17 µg/m3, improvements in annual average visibility resulting from attainment of the new annual PM2.5 primary standard are expected to be perceptible (i.e., to exceed 1 deciview). Based on annual mean PM2.5 data reported in Table 12-2 of the Criteria Document and Table V-12 in the Staff Paper, many cities in the Northeast, Midwest, and Southeast, as well as Los Angeles, would be expected to see perceptible improvement in visibility if the annual PM2.5 primary standard is attained.

In Washington, DC, for example, where the IMPROVE network [IMPROVE (Interagency Monitoring of PROtected Visual Environments) is a visibility monitoring network managed cooperatively by EPA, Federal land management agencies, and State representatives.] An analysis of IMPROVE data for 1992-1995 is found in Sisler et al. (1996). shows annual mean PM2.5 concentrations at about 19 µg/m3 during 1992-1995, approximate annual average visibility would be expected to improve from 21 km visual range (29 deciview) to 27 km (27 deciview). Annual average visibility in Philadelphia, where annual PM2.5 levels have been recently measured at 17 µg/m3, would be expected to change from about 24 to 27 km, an improvement of about 1 deciview. In Los Angeles, where recent data shows annual mean PM2.5 concentrations at approximately 30µg/m3, visibility would be expected to improve from about 19 to 34 km (30 to 24 deciview) if the new annual primary PM2.5 standard is attained.

It is important to note that some urban areas, many in the eastern United States, would be expected to have annual mean PM2.5 concentrations reduced below the primary standard level of 15 µg/m3when implementation of regional control strategies for PM and other air quality programs, such as those addressing acid rain and mobile sources, are taken into account together. On the other hand, some urban areas with annual PM2.5 levels at or below the 15µg/m3 level would be expected to see little, if any, improvement in annual average visibility. This may be particularly true of certain western urban areas that are dominated by coarse rather than fine particles. The Administrator also considered the potential effect on urban visibility if the 24-hour 98th percentile PM2.5 standard of 65 m3 is attained. In areas with violations caused by localized hot spots, the 24-hour standard might have little effect other than on visible source emissions. In other areas, for example, with seasonally high woodsmoke, a more areawide improvement is possible. In such urban areas, attainment of the 24-hour standard would be expected to reduce, to some degree, the number and intensity of ``bad visibility'' days, i.e., the 20% of days having the greatest impairment over the course of a year. For example, maximum 24-hour PM2.5 concentrations have been recorded in recent years at over 140 µg/m3 at several California locations. If the level and frequency of peak PM concentrations are reduced, improvements would be expected in those days where visibility is worst, even in urban areas having annual averages below the annual PM2.5 primary standard. Having concluded that attainment of the annual and 24-hour PM2.5 primary standards would lead to visibility improvements in many eastern and some western urban areas, the Administrator also considered potential improvements to visibility on a regional scale. In the rural East, attainment of the PM2.5 primary standards could result in regional visibility improvement, e.g., in certain mandatory Class I Federal areas such as Shenandoah and Great Smoky Mountains National Park, if regional control strategies are adopted and carried out in order to reduce the impact of long-range transport of fine particles such as sulfates. Fine particle emission reductions achieved by other air quality programs, such as those to reduce acid rain or mobile source emissions, are also expected to improve Eastern regional visibility conditions (U.S. EPA, 1993). In the West, strategies to attain the primary PM PM2.5 standards are less likely to significantly improve visibility on a regional basis. However, areas downwind from large urban areas, such as Southern California, would likely see some improvement in annual average visibility.

Based on the foregoing, the Administrator concludes that attainment of PM2.5 secondary standards set at the level of the primary standards for PM2.5 would be expected to result in visibility improvements in the eastern United States at both urban and regional scales, but little or no change in the western United States except in and near certain urban areas. Additionally, the Administrator determined that attainment of secondary standards equivalent to the suite of PM2.5 primary standards for particulate matter would address some but not all of the effects of particulate matter on visibility. The extent to which these effects would be addressed is expected to vary regionally.

The Administrator then considered the potential effectiveness of a regional haze program to address the remaining effects of particulate matter on visibility (i.e., those that would not be addressed through attainment of secondary standards identical to the suite of PM2.5 primary standards). A program to address the widespread, regionally uniform type of haze caused by a multitude of sources is required by sections 169A and 169B of the Act. In 1977, Congress established as a national goal ``the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory Class I Federal areas which impairment results from manmade air pollution'', section 169A(a)(1) of the Act. The EPA is required by section 169A(a)(4) of the Act to promulgate regulations to ensure that ``reasonable progress'' is achieved toward meeting the national goal. EPA originally deferred establishment of a program to address regional haze in 1980 due to the need for greater scientific and technical knowledge, but the current Criteria Document and Staff Paper cite information supporting the Administrator's conclusion that the scientific state of understanding and analytical tools are now adequate to develop such a program. Because regional emission reductions are needed to make visibility improvements in mandatory Class I Federal areas, the structure and requirements of sections 169A and 169B of the Act, provide for visibility protection programs that can be more responsive to the factors contributing to regional differences in visibility than can programs addressing a nationally applicable secondary NAAQS. The visibility goal is more protective than a secondary NAAQS since the goal addresses any man-made impairment rather than just impairment at levels determined to be adverse.

Thus, an important factor considered in this review is whether a regional haze program, in conjunction with secondary standards set identical to the suite of PM2.5 primary standards, would provide appropriate protection for visibility in non-Class I areas. The Administrator continues to believe that the two programs and associated control strategies should provide such protection due to the regional approaches needed to manage emissions of pollutants that impair visibility in many of these areas. Regional strategies implemented to attain the NAAQS, meet other air program goals, and make reasonable progress toward the national visibility goal in mandatory Class I Federal areas are expected to improve visibility in many urban and non-Class I areas as well. The following recommendation from the 1993 report of the National Research Council, Protecting Visibility in National Parks and Wilderness Areas, addresses this point: Efforts to improve visibility in Class I areas also would benefit visibility outside these areas. Because most visibility impairment is regional in scale, the same haze that degrades visibility within or looking out from a national park also degrades visibility outside it. Class I areas cannot be regarded as potential islands of clean air in a polluted sea.

Before making a final decisions on the secondary standards, the Administrator also considered a number of public comments that addressed this aspect of the proposal. Some commenters suggested setting secondary standards for PM2.5 more stringent than the proposed primary standards for the purpose of addressing visibility impairment and other environmental effects. For the reasons discussed above in this unit, however, the Administrator has concluded that this

may not be an effective and would not be an appropriate means of protecting against visibility impairment in all parts of the country. Other commenters raised the possibility of establishing a nationally applicable secondary standard defined as a ``floor,'' or increment, above regionally specific background levels of PM2.5 or associated visibility. Although this idea is of interest and may warrant further study, the Administrator determined that it was not appropriate to pursue such an approach at this time for two principal reasons. First, the Agency does not currently have adequate scientific information to establish a specific floor or increment level that would protect against adverse effects nationally, nor is it clear as a conceptual matter whether further information would support selection of a single, uniform increment as providing an appropriate degree of protection in all areas of the country. Second, there are serious, unresolved questions about whether such an approach is consistent with the statutory language and purposes of section 109 of the Act.

*Other commenters argued that national secondary standards equivalent to the proposed PM2.5. primary standards are not necessary or not supported by the Administrator's findings. As noted earlier, however, it is clear that coarse and fine particles can cause adverse effects on visibility and significant quantitative data exist to demonstrate that visibility impairment occurs at small concentrations of PM2.5. Substantial efforts have been put forth to assess the effects of PM on visibility. For example, the Grand Canyon Visibility Transport Commission(EPA established the Grand Canyon Visibility Transport Commission (GCVTC) in 1991 under section 169B of the Act. Section 169B(d) requires visibility transport commissions to assess the ``adverse impacts on visibility from potential or projected growth in emissions'' and to recommend to EPA measures to remedy such adverse impacts. The Commission issued its final report in June 1996.) spent several years and significant effort studying the effects of pollution on 16 mandatory Class I Federal areas on the Colorado plateau and has made recommendations to the Administrator for actions to improve visibility in these areas (GCVTC, 1996). All of the mandatory Class I Federal areas studied by the GCVTC with monitoring data have annual mean PM2.5 concentrations below 5 µg/m3 (Sisler, 1996) while also documenting anthropogenic visibility impairment. The Southern Appalachian Mountain Initiative [*The Southern Appalachian Mountain Initiative is a voluntary effort begun in 1993. Participants include eight southeastern States, Federal land managers, EPA, and representatives from industry and environmental groups. A final report has not been issued to date. 54 Indeed, Congress recognized when it adopted section 169A that the ``visibility problem is caused primarily by emission into the atmosphere of sulfur dioxide, oxides of nitrogen and particulate matter, especially fine particulate matter, from inadequately controlled sources.'' H.R. Rep. No. 95-294 at 204 (1977)]. *is currently assessing air pollution impacts on visibility, terrestrial resources, and aquatic resources in the southeastern U.S. in order to recommend measures to remedy existing and prevent future adverse effects on these air quality related values. The IMPROVE network shows that all of the mandatory Class I Federal areas in the SAMI region have annual mean PM2.5concentrations for 1992-95 between 11.0-13.5 µg/m3 (Sisler, 1996). The inclusion in section 169A of the Act*

of a national visibility goal of no manmade impairment also places significant value on reducing PM concentrations and resulting visibility impairment to low levels. [Indeed, Congress recognized when it adopted section 169A that the ``visibility problem is caused primarily by emission into the atmosphere of sulfur dioxide, oxides of nitrogen and particulate matter, especially fine particulate matter, from inadequately controlled sources." H.R. Rep. No. 95-294 at 204 (1977)].

The differences between the fine particle levels associated with visibility impairment in eastern and western mandatory Class I Federal areas provide further impetus to act under the provisions of sections 169A and 169B enabling the Administrator to establish a regionally-tailored visibility program to address impairment of visibility in mandatory Class I Federal areas. For these reasons, the Administrator has concluded that a national regional haze program allowing for regional approaches to addressing fine particle pollution, combined with a nationally applicable level of protection achieved through secondary PM2.5 standards set equal to the suite of primary standards, would be more effective in addressing regional variations in the adverse effects of PM2.5 on visibility than establishing national secondary standards for particulate matter that are lower than the suite of PM2.5 primary standards. The Administrator emphasizes that in order to appropriately address the regional differences in adverse effects of particulate matter on visibility, it is essential to establish secondary standards for PM2.5 equivalent to the primary standards and an effective new regional haze program. A regional haze program will be particularly important in those areas of the country that do not exceed any of the primary standards for PM2.5, yet still experience significant visibility impairment due to particulate matter. The EPA will propose a regional haze regulation in the near future.

In addition to providing a more regionally tailored approach than establishing a more stringent national secondary standard, an effective regional haze program will also fulfill the Administrator's regulatory responsibility under sections 169A and 169B of the Act to address both reasonably attributable impairment and regional haze impairment in mandatory Class I Federal areas. Indeed, regional haze has been shown to be the principal cause of visibility impairment in mandatory Class I Federal areas today. Thus, the promulgation of a regional haze program in conjunction with secondary standards for PM2.5 equivalent to the suite of primary standards will serve as an appropriate approach for addressing adverse effects of visibility that vary regionally, and it will also establish a comprehensive program for making reasonable progress toward the national visibility goal in mandatory Class I Federal areas by addressing visibility impairment in the form of both source-specific impacts and regional haze. Further, the regional haze rulemaking will fulfill the Administrator's responsibilities to address the visibility protection recommendations of the Grand Canyon Visibility Transport Commission, pursuant to section 169B(e) of the Act.

The Administrator recognizes that people living in certain urban areas may place a high value on unique scenic resources in or near these areas, and as a result might experience visibility problems attributable to sources that would

not necessarily be addressed by the combined effects of a regional haze program and secondary standards identical to the suite of primary standards for PM2.5. Commenters fromcertain western cities and States raised this issue. In the Administrator's judgment, State or local regulatory approaches, such as past action in Colorado to establish a local visibility standard for the City of Denver, would be more appropriate and effective in addressing these special situations because of the localized and unique characteristics of the problems involved. Visibility in an urban area located near a mandatory Class I Federal area can also be improved through State implementation of the current visibility regulations, by which emission limitations can be imposed on a source or group of sources found to be contributing to ``reasonably attributable'' impairment in the mandatory Class I Federal area. EPA also intends to pursue opportunities to obtain information on urban and non-Class I area visibility through examination of available fine particle monitoring data. Current or planned monitoring networks and initiatives, such as monitoring and chemical analysis of PM2.5 in urban and background sites, efforts to better characterize real-time environmental conditions in major populations centers, and new automated airport visibility monitoring networks should provide data needed to evaluate trends in these areas. This information should help to better characterize the nature and spatial extent of urban and non-Class I visibility problems and thus serve to inform future decisions on NAAQS revisions or other appropriate measures. Based on all of the considerations discussed, the Administrator has decided to establish secondary standards identical to the suite of PM2.5 primary standards, in conjunction with a regional haze program under sections 169A and 169B of the Act, as the most appropriate and effective means of addressing the welfare effects associated with visibility impairment. Together, the two programs and associated control strategies should provide appropriate protection against the effects of PM on visibility and enable all regions of the country to make reasonable progress toward the national visibility goal.

2. Materials damage and soiling effects. Annual and 24-hour secondary standards for materials damage and soiling effects of PM were established in 1987 at levels equal in all respects to the primary standards. As discussed in the Criteria Document and Staff Paper, particles affect materials by promoting and accelerating the corrosion of metals, by degrading paints, and by deteriorating building materials such as concrete and limestone. Soiling is found to reduce the aesthetic quality of buildings and objects of historical or social interest. Past studies have found that residential properties in highly polluted areas typically have lower values than those in less polluted areas. Thus, at high enough concentrations, particles become a nuisance and result in increased cost and decreased enjoyment of the environment. In the proposal, EPA proposed to establish secondary standards for PM10 and PM2.5 identical to the suite of proposed primary standards. Several comments recommended setting secondary standards at levels more stringent than the proposed primary standards in order to address various welfare effects of PM, including soiling and materials damage, acid deposition, and visibility. Some commenters specifically suggested changing the form or level of the proposed 24-hour, 98th percentile PM standards to better

protect against elevated PM episodes and associated soiling, materials damage, and visibility effects.

After reviewing the extent of relevant studies and other information provided since the 1987 review of the PM standards, the Administrator concurs with staff and CASAC conclusions that the available data do not provide a sufficient basis for establishing a separate secondary standard based on soiling or materials damage alone. In the Administrator's judgment, however, setting secondary standards identical to the suite of PM2.5 and PM10 primary standards would provide increased protection against the effects of fine particles and retain an appropriate degree of control on coarse particles. Accordingly, the Administrator establishes the secondary standards for PM2.5 identical to the suite of primary standards to protect against materials damage and soiling effects of PM.

Significant Final Rules in FY 1998

Control of Emissions of Air Pollution From Nonroad Diesel Engines 62 FR 56967

SUMMARY: In this action, EPA is finalizing new emission standards for nonroad diesel engines. The affected engines are used in most land-based nonroad equipment and some marine applications. The emission reductions resulting from the new standards will translate into significant, long-term improvements in air quality in many areas of the U.S. For engines in this large category of pollution sources, the standards for oxides of nitrogen and particulate matter emissions will be reduced by up to two-thirds from current standards. Overall, this program will provide much-needed assistance to states facing ozone and particulate air quality problems, which are causing a range of adverse health effects for their citizens, especially in terms of respiratory impairment and related illnesses.

From the discussion of the benefits of the rule: "In addition to the benefits of reducing ozone within and transported into urban ozone nonattainment areas, the NOX reductions from the new standards are expected to have beneficial impacts with respect to crop damage, secondary particulate formation, acid deposition, eutrophication, visibility, and forests, as described earlier. Because of the difficulty of quantifying the monetary value of these societal benefits, the cost-effectiveness values presented do not assign any numerical value to these additional benefits. However, based on an analysis of existing studies that have estimated the value of such benefits in the past, the Agency believes that the actual monetary value of the multiple environmental and public health benefits produced by large NOX reductions similar to those projected under this final rule will likely be greater than the estimated compliance costs."

Finding of Significant Contribution and Rulemaking for Certain States in the Ozone Transport Assessment Group (OTAG) Region for Purposes of Reducing Regional Transport of Ozone 63 FR 57355

SUMMARY: In accordance with the Clean Air Act (CAA), today's action is a final rule to require 22 States and the District of Columbia to submit State implementation plan (SIP) revisions to prohibit specified amounts of emissions of oxides of nitrogen (NOX)--one of the precursors to ozone (smog) pollution--for the purpose of reducing NOX and ozone transport across State boundaries in the eastern half of the United States. Ground-level ozone has long been recognized, in both clinical and epidemiological research, to affect public health. There is a wide range of ozone-induced health effects, including decreased lung function (primarily in children active outdoors), increased respiratory symptoms (particularly in highly sensitive individuals), increased hospital admissions and emergency room visits for respiratory causes (among children and adults with pre-existing respiratory disease such as asthma), increased inflammation of the lung, and possible long-term damage to the lungs.

In today's action, EPA finds that sources and emitting activities in each of the 22 States and the District of Columbia (23 jurisdictions) emit NOX in amounts that significantly contribute to nonattainment of the 1-hour and 8-hour ozone national ambient air quality standards (NAAQS), or will interfere with maintenance of the 8-hour NAAQS, in one or more downwind States. Further, by today's action, EPA is requiring each of the affected upwind jurisdictions (sometimes referred to as upwind States) to submit SIP revisions prohibiting those amounts of NOX emissions which significantly contribute to downwind air quality problems. The reduction of those NOX emissions will bring NOX emissions in each of those States to within the resulting statewide NOX emissions budget levels established in today's rule. The 23 jurisdictions are: Alabama, Connecticut, Delaware, District of Columbia, Georgia, Illinois, Indiana, Kentucky, Massachusetts, Maryland, Michigan, Missouri, North Carolina, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, South Carolina, Tennessee, Virginia, West Virginia, and Wisconsin. These States will be able to choose any mix of pollution-reduction measures that will achieve the required reductions.

Discussion of ecological impacts from summary information in the rule: " Each year, ground-level ozone above background is also responsible for significant agricultural crop yield losses. Ozone also causes noticeable foliar damage in many crops, trees, and ornamental plants (i.e., grass, flowers, shrubs, and trees) and causes reduced growth in plants. Studies indicate that current ambient levels of ozone are responsible for damage to forests and ecosystems (including habitat for native animal species)."

From OMB's 2000 Report to Congress on the Costs and Benefits of Federal Regulations: "The monetized benefits reflect improvements in health, crop yields, visibility, and ecosystem protection. "Due to practical analytical limitations, the EPA is not able to quantify and/or monetize all potential benefits of this action.' (63 FR 57478"

Integrated NESHAP and Effluent Guidelines: Pulp and Paper 63 FR 18504

SUMMARY: This action promulgates effluent limitations guidelines and standards under the Clean Water Act (CWA) for a portion of the pulp, paper, and paperboard industry, and national emission standards for hazardous air pollutants (NESHAP) under the Clean Air Act (CAA) as amended in 1990 for the pulp and paper production source category.

EPA is also promulgating best management practices under the CWA for a portion of the pulp, paper, and paperboard industry, and new analytical methods for 12 chlorinated phenolic pollutants and for adsorbable organic halides (AOX). This action consolidates into 12 subcategories what had once been 26 subcategories of effluent limitations guidelines and standards for the pulp, paper, and paperboard industry, and revises the existing effluent limitations guidelines and standards for the Bleached Papergrade Kraft and Soda subcategory and the Papergrade Sulfite subcategory. The revised effluent limitations guidelines and standards require existing and new facilities within these two subcategories to limit the discharge of pollutants into navigable waters of the United States and to limit the introduction of pollutants into publicly owned treatment works. The NESHAP requires existing and new major sources within the pulp and paper production source category to control emissions using the maximum achievable control technology (MACT) to control hazardous air pollutants (HAP).

EPA is revising the effluent limitations guidelines and standards for the Bleached Papergrade Kraft and Soda subcategory and the Papergrade Sulfite subcategory primarily to reduce the discharge of toxic and nonconventional chemical compounds found in the effluents from these mills. Discharge of these pollutants into the freshwater, estuarine, and marine ecosystems may alter aquatic habitats, affect aquatic life, and adversely impact human health. Discharges of chlorinated organic compounds from chlorine bleaching, particularly dioxins and furans, are human carcinogens and human system toxicants and are extremely toxic to aquatic life. The final effluent limitations guidelines and standards for the Bleached Papergrade Kraft and Soda and Papergrade Sulfite subcategory are estimated to reduce the discharge of adsorbable organic halides (AOX) by 28,210 kkg/year; chloroform by 45 kkg/year; chlorinated phenolics by 47 kkg/year; and 2,3,7,8-TCDD (dioxin) and 2,3,7,8-TCDF (furan) by 125 gm/year. These reductions will permit all 19 dioxin/furan-related fish consumption advisories downstream of pulp and paper mills to be lifted.

EPA is revising the subcategorization scheme for the effluent limitations guidelines and standards because the new scheme better defines the processes typically found in U.S. mills and thus results in what ultimately will be a streamlined regulation that can be implemented more easily by the permit writer. With the exception of the new effluent limitations guidelines and standards for the Bleached Papergrade Kraft and Soda and Papergrade Sulfite subcategories, EPA is making no substantive changes to the limitations and standards applicable to the newly reorganized subcategories. Those portions of the existing pulp, paper, and paperboard effluent limitations guidelines and standards that are not substantively

amended by this action are not subject to judicial review; nor is their effective date affected by this reorganization.

The HAPs emitted by facilities covered by the NESHAP include such compounds as methanol, chlorinated compounds, formaldehyde, benzene, and xylene. The health effects of exposure to these and other HAPs at pulp and paper mills can include cancer, respiratory irritation, and damage to the nervous system. The final NESHAP is expected to reduce baseline emissions of HAP by 65 percent or 139,000 Mg/yr.

The pollutant reductions resulting from these rules will achieve the primary goals of both the CAA and CWA, which are to ``enhance the quality of the Nation's air resources so as to promote the public health and welfare and productive capacity of its population'' and to ``restore and maintain the chemical, physical, and biological integrity of the Nation's waters,'' respectively. These rules will result in continued environmental improvement at reasonable cost by providing flexibility in when and how results are achieved and, for certain mills, by providing incentives to surpass baseline requirements. Elsewhere in today's Federal Register, EPA is concurrently proposing NESHAP to control hazardous air pollutants from chemical recovery combustion sources at kraft, soda, sulfite, and stand-alone semi-chemical pulp mills.

In another proposed rule published in today's Federal Register, EPA is also proposing a regulation that would require mills enrolled in the Voluntary Advanced Technology Incentives Program being promulgated for the Bleached Papergrade Kraft and Soda subcategory to submit a plan specifying research, construction, and other activities leading to achievement of the Voluntary Advanced Technology effluent limitations, with accompanying dates for achieving these milestones. Second, EPA proposes to authorize Bleached Papergrade Kraft and Soda subcategory mills under certain circumstances to submit a certification based on process changes in lieu of monitoring for chloroform. Third, although not proposing totally chlorine-free (TCF) technologies for new source performance standards under the CWA for Bleached Papergrade Kraft and Soda subcategory at this time, EPA is requesting comments and data regarding the feasibility of TCF processes for this subcategory, especially the range of products made and their specifications. In that proposal EPA is also requesting comments and data regarding the effluent reduction performance of TCF processes for this subcategory.

Discussion of non-human health benefits of the rule: Under the section" EPA's Long-Term Environmental Goals." " EPA's long-term goals include improved air quality, improved water quality, the elimination of fish consumption advisories downstream of mills, and the elimination of ecologically significant bioaccumulation. An integral part of these goals is an industry committed to continuous environmental improvement--an industry that aggressively pursues research and pilot projects to identify technologies that will reduce, and ultimately eliminate, pollutant discharges from existing and new sources.

OMB Discussion of Rule and Related benefits: "Other quantified (but not monetized) annual benefits include lifting of 19 dioxin/furan - related fish consumption advisories; elimination of 3 exceedences of human health ambient water quality concentration standards (AWQC); and elimination of 19 exceedences of aquatic life AWQCs, Unquantified benefits include non-cancer human health effects and improvements in fish and wildlife habitats.

Land Disposal Restrictions Phase IV: Final Rule Promulgating Treatment Standards for Metal Wastes and Mineral Processing Wastes; Mineral Processing Secondary Materials and Bevill Exclusion Issues; Treatment Standards for Hazardous Soils, and Exclusion of Recycled Wood Preserving Wastewaters; Final Rule 63 FR 28556

SUMMARY: This rule promulgates Land Disposal Restrictions treatment standards for metal-bearing wastes, including toxicity characteristic metal wastes, and hazardous wastes from mineral processing. The set of standards being applied to these wastes is the universal treatment standards. These standards are based upon the performance of the Best Demonstrated Available technologies for treating these, or similar, wastes. This rule also revises the universal treatment standards for twelve metal constituents, which means that listed and characteristic wastes containing one or more of these constituents may have to meet different standards than they currently do.

In a related section regarding wastes and secondary materials from mineral processing, EPA is amending the rules to define which secondary materials from mineral processing are considered to be wastes and potentially subject to Land Disposal Restrictions. The intended effect is to encourage safe recycling of mineral processing secondary materials by reducing regulatory obstacles to recycling, while ensuring that hazardous wastes are properly treated and disposed. EPA also is finalizing decisions on a set of mineral processing issues wastes which courts have been remanded to EPA. These include retaining the Toxicity Characteristic Leaching Procedure as the test for identifying the toxicity characteristic for mineral processing wastes, and readdressing the regulatory status of a number of miscellaneous mineral processing wastes.

This rule also amends the LDR treatment standards for soil contaminated with hazardous waste. The purpose of this revision is to create standards which are more technically and environmentally appropriate to contaminated soils than those which currently apply.

Finally, this rule excludes from the definition of solid waste certain shredded circuit boards in recycling operations, as well as certain materials reused in wood preserving operations.

Locomotive Emission Standards 63 FR 18977

SUMMARY: EPA is promulgating emission standards and associated regulatory requirements for the control of emissions from locomotives and locomotive engines as required by the Clean Air Act section 213(a)(5). The primary focus of

this rule is the reduction of emissions of oxides of nitrogen (NOX). The standards will take effect in 2000 and will ultimately result in a more than 60 percent reduction in NOX from locomotives. NOX is a precursor to the formation of ground level ozone, which causes health problems such as damage to lung tissue, reduction of lung function, and sensitization of lungs to other irritants, as well as damage to terrestrial and aquatic ecosystems. EPA is also promulgating standards for emissions of hydrocarbons (HC), carbon monoxide (CO), particulate matter (PM), and smoke. The overall cost-effectiveness of today's emissions standards is 158 dollars per ton of NOX, PM and HC reduced. Today's rule also includes a variety of provisions to implement the standards and to ensure that the standards are met in-use. These provisions include certification test procedures, and assembly line and in-use compliance testing programs. Also included in today's rule is an emissions averaging, banking and trading program to improve feasibility and provide flexibility in achieving compliance with the proposed standards. Finally, EPA is promulgating regulations that preempt certain state and local requirements relating to the control of emissions from new locomotives and new locomotive engines, pursuant to Clean Air Act section 209(e).

From the discussion of the benefits in the rule: " This section contains a brief summary of the emission benefits expected from the national locomotive emission standards contained in this action. The complete analysis of the expected benefits is contained in the RSD. The primary focus of this regulation is on reducing NOX and PM, but reductions in HC will also be achieved (For information on the impacts of NOX emissions see, ``Nitrogen Oxides: Impacts on Public Health and the Environment," EPA 452/R-97-002, August 1997.) Because the emission standards for CO adopted today are intended as caps to prevent increases in CO emissions, no CO reductions are expected to result from today's action.[8]

*The benefits analysis was performed in several steps. First, the baseline locomotive fleet composition, emissions rates and total inventory were determined. Second, future fleet composition was projected, from which the emission factors for the fleet were calculated for NOX, PM and HC. Future emission inventories were then calculated by multiplying these emission factors by fuel consumption to give total tons of emissions per year. Finally, those controlled emission inventories were compared to the baseline fleet emission inventories to arrive at mass NOX, PM and HC emission reductions for the fleet. Table VI-1 contains a summary of both the fleet percentage and mass reductions for NOX>, PM and HC. It should be noted that both the total emissions and the projected reductions are larger than the corresponding numbers in the proposal. This is because this final analysis includes small freight and passenger railroads that were omitted in the draft analysis. While EPA expects some emission reductions to occur in 2000 and 2001 under today's action, Table VI-1 begins with 2002 because that is the first year that the locomotive emission standards are fully phased i*n.

NESHAP: Source Categories: (SOCMI) and and Other Processes Subject to the Negotiated Regulation for Equipment Leaks 63 FR 67787

SUMMARY: On September 12, 1994, the EPA proposed Standards of Performance for New Stationary Sources: Volatile Organic Compound Emissions from the Synthetic Organic Chemical Manufacturing Industry Wastewater. On October 11, 1995, the EPA issued a supplement to the proposal. The action proposed today clarifies and revises the previously proposed rule and proposes to add Appendix J to part 60. Volatile organic compounds (VOC), when emitted into the ambient air, are precursors to the formation of tropospheric ozone. A wide variety of acute and chronic respiratory health effects and welfare (e.g., agricultural, ecosystem) effects have been attributed to concentrations of ozone commonly measured in the ambient air throughout the U.S. Appendix J to part 60, How to Determine Henry's Law Constants, Fm Values, Fr Values, and Fe Values for Organic Compounds, is being proposed today. This appendix provides the methodology for determining Henry's law constants, fraction measured (Fm) values, fraction removed values (Fr), and fraction emitted (Fe) values.

From the discussion of the benefits in the rule: "Studies of the major cash crops in the U.S. indicate that ozone is responsible for several billion dollars in agricultural crop yield loss each year. Ozone also causes noticeable foliar damage in many crops which reduces marketability and value. Finally, it appears that ozone is responsible for forest and ecosystem damage, which may be exhibited as foliar damage, reduced growth rate, and increased susceptibility to insects and disease."

Significant Final Rules in FY 1999

Nonroad Spark-Ignition Engines At or Below 19 Kilowatts (25 Horsepower) (Phase 2) 64 FR 15208

SUMMARY: In this action, EPA is finalizing a second phase of emission regulations to control emissions from new nonroad spark-ignition nonhandheld engines at or below 19 kilowatts (25 horsepower). These engines are used principally in lawn and garden equipment in applications such as lawnmowers and garden tractors. The standards will result in an estimated 59 percent reduction of emissions of hydrocarbons plus oxides of nitrogen from those achieved under the current Phase 1 standards applicable to nonhandheld engines. The standards will result in important reductions in emissions which contribute to excessively high ozone levels in many areas of the United States.

From the rule description: The newly revised primary NAAQS (See 62 FR 38896, Friday, July 18, 1997) for ozone based on an 8-hour standard of 0.08 parts per million (ppm) is set at a level that, with an adequate margin of safety, is protective of public health. EPA also believes attainment of the new primary standard will substantially protect vegetation. Ozone effects on vegetation include

reduction in agricultural and commercial forest yields, reduced growth and decreased survivability of tree seedlings, increased tree and plant susceptibility to disease, pests, and other environmental stresses, and potential long-term effects on forests and ecosystems. High levels of ozone have been recorded even in relatively remote areas, since ozone and its precursors can travel hundreds of miles and persist for several days in the lower atmosphere. Ozone damage to plants, including both natural forest ecosystems and crops, occurs at ozone levels between 0.06 and 0.12 ppm. (see U.S. EPA, Review of NAAQS for Ozone, p. X-10.)

Repeated exposure to ozone levels above 0.04 ppm can cause reductions in the yields of some crops above ten percent.(See U.S. EPA, Review of NAAQS for Ozone, p. X-10.) While strains of some crops are relatively resistant to ozone, many crops experience a loss in yield of 30 percent at ozone concentrations below the pre-revised primary NAAQS. (see See 62 FR 38856, Friday, July 18, 1997.) The value of crops lost to ozone damage, while difficult to estimate precisely, is on the order of $2 billion per year in the United States. (U.S. EPA, Review of NAAQS for Ozone, p. X-22.) The effect of ozone on complex ecosystems such as forests is even more difficult to quantify. However, there is evidence that some forest types are negatively affected by ambient levels of ozone. (U.S. EPA, Review of NAAQS for Ozone, p. X-27)

Specifically, in the San Bernadino Mountains of southern California, ozone is believed to be the agent responsible for the slow decline and death of ponderosa pine trees in these forests since 1962.(U.S. EPA, Review of NAAQS for Ozone, p. X-29.)

Finally, by trapping energy radiated from the earth, tropospheric ozone may contribute to heating of the earth's surface, thereby contributing to global warming (that is, the greenhouse effect),(NRC, Rethinking the Ozone Problem, p. 22). although tropospheric ozone is also known to reduce levels of UVB radiation reaching the earth's surface, the increase of which is expected to result from depletion of stratospheric ozone. (The New York Times, September 15, 1992, p. C4.)3. Estimated Emissions Impact of the Final Regulation

The emission standards set by today's action should reduce average in-use exhaust HC+NOX emissions from small SI nonhandheld engines approximately 59 percent beyond Phase 1 standards for nonhandheld engines by year 2027, by which time a complete fleet turnover is realized. This translates into an annual nationwide reduction of roughly 395,000 tons of exhaust HC+NOX in year 2027 over that expected from Phase 1. Reductions in CO beyond Phase 1 levels, due to improved technology, are also to be expected by year 2027.

Along with the control of all hydrocarbons, these standards should be effective in reducing emissions of those hydrocarbons considered to be hazardous air pollutants (HAPs), including benzene and 1,3-butadiene. However, the magnitude of reduction would depend on whether the control technology reduces the individual HAPs in the same proportion as total hydrocarbons.

These emission reduction estimates are based on in-use population projections using growth estimates, engine attrition (scrappage), activity indicators and new and in-use engine emission factors. Data on activity

indicators were based on the Phase 1 small SI regulation. Estimates of engine populations were based on population data available from the PSR databases (Power Systems Research, Engine Data and Parts Link data bases, St. Paul, Minnesota, 1992) and data provided by Engine and Equipment manufacturers and on a study done for the California Air Resources Board by Booz Allen & Hamilton (BAH). Population projections into the future are based on a linear growth assumption. Attrition rates (based on the probability that an engine remains in service into a specific calendar year) for all engines included in this analysis are developed on the assumption that the equipment attrition function may be represented by acumulative Normal distribution function. The in-use emission factor is based on a multiplicative deterioration factor which is a function of the square root of hours of equipment usage.

For the analysis summarized in Table 4, emission inventories were developed using EPA's ***NONROAD*** *Model for the two regulated nonhandheld engine classes as well as for all pieces of equipment using engines covered by this rule. The total annual nationwide HC, NOXand CO emissions from small SI nonhandheld engines included in this rule were estimated for both the baseline (that is, with Phase 1 controls applied) and controlled (Phase 2) scenarios. For the controlled scenario, EPA assumed all nonhandheld engines would be converted to overhead valve technology. As for deterioration factors, they were determined in some cases using manufacturer-supplied confidential in-use emission data and for others EPA depended on relevant information from EPA's certification data base.*

National Pollutant Discharge Elimination System--Regulations for Revision of the Water Pollution Control Program Addressing Storm Water Discharges; Final Rule 64 FR 68722

SUMMARY: Today's regulations (Phase II) expand the existing National Pollutant Discharge Elimination System (NPDES) storm water program (Phase I) to address storm water discharges from small municipal separate storm sewer systems (MS4s) (those serving less than 100,000 persons) and construction sites that disturb one to five acres. Although these sources are automatically designated by today's rule, the rule allows for the exclusion of certain sources from the national program based on a demonstration of the lack of impact on water quality, as well as the inclusion of others based on a higher likelihood of localized adverse impact on water quality. Today's regulations also exclude from the NPDES program storm water discharges from industrial facilities that have ``no exposure'' of industrial activities or materials to storm water. Finally, today's rule extends from August 7, 2001 until March 10, 2003 the deadline by which certain industrial facilities owned by small MS4s must obtain coverage under an NPDES permit. This rule establishes a cost-effective, flexible approach for reducing environmental harm by storm water discharges from many point sources of storm water that are currently unregulated.

EPA believes that the implementation of the six minimum measures identified for small MS4s should significantly reduce pollutants in urban storm water compared to existing levels in a cost-effective manner. Similarly, EPA believes that implementation of Best Management Practices (BMP) controls at small construction sites will also result in a significant reduction in pollutant discharges and an improvement in surface water quality. EPA believes this rule will result in monetized financial, recreational and health benefits, as well as benefits that EPA has been unable to monetize. Expected benefits include reduced scouring and erosion of streambeds, improved aesthetic quality of waters, reduced eutrophication of aquatic systems, benefit to wildlife and endangered and threatened species, tourism benefits, biodiversity benefits and reduced costs for siting reservoirs. In addition, the costs of industrial storm water controls will decrease due to the exclusion of storm water discharges from facilities where there is ``no exposure'' of storm water to industrial activities and materials.

From OMB's 2001 Report, Making sense of Regulation: 2001 Report to Congress on the Costs and Benefits of Regulations and Unfunded Mandates on State, Local, and Tribal Entities: "Estimates of individual willingness to pay for water quality improvements in fresh water and marine water indicate the size of the monetized benefit.

T'here are additional benefits to storm water control that cannot be quantified or monetized. Thus the current estimate of monetized benefits may understate the true value of storm water controls because it omits many ways in which society is likely to benefit from reduced storm water pollution, such as improved aesthetic quality of waters, benefits to wildlife and to threatened and endangered species, cultural values, and biodiversity benefits.' (64 FR 68794)"

Persistent Bioaccumulative Toxic (PBT) Chemicals; Final Rule 64 FR 58666

SUMMARY: EPA is lowering the reporting thresholds for certain persistent bioaccumulative toxic (PBT) chemicals that are subject to reporting under section 313 of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) and section 6607 of the Pollution Prevention Act of 1990 (PPA). EPA is also adding a category of dioxin and dioxin-like compounds to the EPCRA section 313 list of toxic chemicals and establishing a 0.1 gram reporting threshold for the category. In addition, EPA is adding certain other PBT chemicals to the EPCRA section 313 list of toxic chemicals and establishing lower reporting thresholds for these chemicals. EPA is removing the fume or dust qualifier from vanadium and adding all forms of vanadium with the exception of vanadium when contained in alloys. EPA is also adding vanadium compounds to the EPCRA section 313 list of toxic chemicals. However, EPA is not lowering the reporting thresholds for either vanadium or vanadium compounds. EPA is taking these actions pursuant to its authority under EPCRA section 313(f)(2) to revise reporting thresholds and pursuant to its authority to add chemicals and chemical categories that meet the EPCRA section 313(d)(2) toxicity criteria. The additions of these chemicals are based on their carcinogenicity or other chronic human

health effects and/or their significant adverse effects on the environment. Today's actions also include modifications to certain reporting exemptions and requirements for those toxic chemicals that are subject to the lower reporting thresholds. This document also announces the effective date of Sec. 372.27 of the Code of Federal Regulations, which contained information collection requirements and which was originally published in the Federal Register on November 30, 1994.

Discussion of non-human health benefits of the rule: "Federal and local perspectives on what may be an acceptable risk are likely to be very different. The roles of local government and the Federal government differ significantly in terms of ensuring environmental quality. In passing EPCRA, Congress determined that it is for the public to take the information reported on the use and releases and other waste management of toxic chemicals, and to determine whether these releases result in potential risks that the community determines warrant further action given other factors, such as economic and environmental conditions, or particularly vulnerable human or ecological populations. Congress did not intend the Federal government to consider these specific local factors prior to determining whether certain information should be made public or prior to determining whether a different threshold should be established for one or more toxic chemicals.

The intent of EPCRA section 313 is to move the determination of what risks are acceptable from EPA to the communities in which the releases occur. This basic local empowerment is a cornerstone of the right-to-know program. EPCRA section 313 establishes an information collection and dissemination program. The burden it imposes is significantly less than the[[Page 58693]]burden imposed by a statute which controls the manufacture, use, and/or disposal of a chemical. EPCRA section 313 requires that a facility use readily available data, or if such data are not available, reasonable estimates to prepare each chemical-specific report. The statute does not require that the facility conduct monitoring or emissions measurements to determine these quantities. This is in contrast to other environmental statutes that may require a facility to monitor releases, change its manufacturing process, install a specific waste treatment technology, or dispose of wastes in a certain manner. As such, the Agency believes that as a matter of policy the standard that must be met to require information pursuant to EPCRA section 313 is less than that required to regulate a chemical under a statute such as the Clean Air Act. See, e.g., Legislative History at 5186.

Further, contrary to assertions by some commenters, EPCRA section 313 does not require the collection of quantitative risk data nor does the statute require that risk data be disseminated to the public. Rather TRI data provide communities with information on releases and other waste management quantities. TRI data cannot, in themselves, provide information on quantitative risks to individual communities. A determination of the potential risk that a chemical release may pose is dependent upon a number of factors, including the toxicity of the chemical, the physical chemical properties of the chemical, the

specific media to which the chemical is released, and site-specific information that will determine the estimated exposures. While TRI data are not in themselves measures of risk, they are an important input that local communities can use along with the factors described in this section to determine potential risks to themselves, their children, their communities, and their environment that may result from releases of toxic chemicals. EPA's decision to lower the reporting threshold for PBT chemicals is rationally related to the EPCRA section 313 goals of informing communities, assisting research and data gathering, and aiding the development of regulations and guidelines. Because PBT chemicals persist in the environment for a significant period of time and bioaccumulate in animal tissues, PBT chemicals have the potential to be pervasive in the environment, in the food chain, and often in humans. In short, for PBT chemicals, releases and other waste management activities for relatively small amounts of PBT chemicals are of concern. Accordingly, pursuant to the intended purposes of EPCRA, even relatively small releases and other waste management activities for PBT chemicals need to be reported in order to inform communities, assist those engaged in research and data gathering, and to aid the development of regulations and guidelines. Lowered reporting thresholds for PBT chemicals are needed to obtain reporting on these relatively small releases and other waste management activities for PBT chemicals. Consequently, EPA believes that including consideration of the quantitative risk in establishing the thresholds would be poor public policy that would be inconsistent with the overall principles of EPCRA….

VII. What Were the Results of EPA's Economic Analysis?

EPA has prepared an economic analysis of the impact of this action, which is contained in a document entitled Economic Analysis of the Final Rule to Modify Reporting of Persistent Bioaccumulative Toxic Chemicals under EPCRA Section 313 (Ref. 67). This document is available in the public docket for this rulemaking. The analysis assesses the costs, benefits, and associated impacts of the rule, including potential effects on small entities. The major findings of the analysis are briefly summarized here.

A. What is the Need for the Rule? Federal regulations exist, in part, to address significant market failures. Markets fail to achieve socially efficient outcomes when differences exist between market values and social values. Two causes of market failure are externalities and information asymmetries. In the case of negative externalities, the actions of one economic entity impose costs on parties that are ``external'' to any market transaction. For example, a facility may release toxic chemicals without accounting for the consequences to other parties, such as the surrounding community, and the prices of that facility's goods or services thus will fail to reflect those costs. The market may also fail to efficiently allocate resources in cases where consumers lack information. For example, where information is insufficient regarding toxic releases, individuals' choices regarding where to live and work may not be the same as if they had more complete information. Since firms ordinarily have little or no incentive to provide information on their releases and other waste management activities involving

toxic chemicals, the market fails to allocate society's resources in the most efficient manner.

This rule is intended to address the market failures arising from private choices about PBT chemicals that have societal costs, and the market failures created by the limited information available to the public about the release and other waste management activities involving PBT chemicals. Through the collection and distribution of facility-specific data on toxic chemicals, TRI overcomes firms' lack of incentive to provide certain information, and thereby serves to inform the public of releases and other waste management of PBT chemicals. This information enables individuals to make choices that enhance their overall well-being. Choices made by a more informed public, including consumers, corporate lenders, and communities, may lead firms to internalize into their business decisions at least some of the costs to society relating to their releases and other waste management activities involving PBT chemicals. In addition, by helping to identify areas of concern, set priorities and monitor trends, TRI data can also be used to make more informed decisions regarding the design of more efficient regulations and voluntary programs, which also moves society towards an optimal allocation of resources.

If EPA were not to take this action adding certain PBT chemicals to EPCRA section 313 and lowering reporting thresholds, the market failure (and the associated social costs) resulting from the limited information on the release and other waste management of PBT chemicals would continue. EPA believes that today's action will improve the scope of multi-media data on the release and other waste management of PBT chemicals. This, in turn, will provide information to the public, empower communities to play a meaningful role in environmental decision-making, and improve the quality of environmental decision-making by government officials. In addition, this action will serve to generate information that reporting facilities themselves may find useful in such areas as highlighting opportunities to reduce chemical use or release or other waste management and thereby lower costs of production and/or waste management. EPA believes that these are sound rationales for adding chemicals to the EPCRA section 313 list of toxic chemicals and lowering reporting thresholds for PBT chemicals."

Significant Final Rules in FY 2000

Phase 2 Emission Standards for New Nonroad Spark-Ignition Handheld Engines at or Below 19 Kilowatts and Minor Amendments to Emission Requirements Applicable to Small Spark-Ignition Engines and Marine Spark-Ignition Engines; Final Rule 65 FR 24267

SUMMARY: In this action, we are finalizing a second phase of regulations to control emissions from new nonroad spark-ignition handheld engines at or below 19 kilowatts (25 horsepower). The engines covered by this action are used principally in handheld lawn and garden equipment applications such as trimmers, leaf blowers, and chainsaws. The standards will result in an estimated 70 percent reduction of emissions of hydrocarbons plus oxides of nitrogen from handheld

engine emissions under the current Phase 1 standards by year 2010. The standards will be phased in beginning with the 2002 model year. The standards will result in important reductions in emissions which contribute to excessively high ozone levels in many areas of the United States. We have estimated the cost at approximately $20 to $56 for individual units and significantly air quality benefits of 3.6 millions of HC over the life of the program.

In March 1999 we adopted Phase 2 regulations for small spark-ignition engines used in nonhandheld equipment. In this action we are including two provisions for Phase 2 nonhandheld engines that would partially modify the scope of the March 1999 final rule. First, we are adopting standards for two additional classes of nonhandheld engines that apply to engines below 100 cubic centimeters displacement used in nonhandheld equipment applications. Second, we are finalizing an option that allows manufacturers to certify engines greater than 19 kilowatts and less than or equal to one liter in displacement to the small engine Phase 2 standards.

With this document, we are also amending the provisions of the existing regulations for small spark-ignition nonroad engines at or below 19 kilowatts and marine spark-ignition nonroad engines. (We proposed these amendments in a separate document, and received no comments objecting to the proposal.) For small spark-ignition nonroad engines at or below 19 kilowatts, we are revising the applicability of the rule to certain engines used in recreational applications and revising the applicability of the handheld emission standards to accommodate cleaner but heavier 4-stroke engines. For marine spark-ignition engines, we are amending the existing regulations to provide compliance flexibility for small volume engine manufacturers during the standards' phase in period. Lastly, we are adopting a minor revision to the existing replacement engine provisions for both small spark-ignition nonroad engines at or below 19 kilowatts and marine spark-ignition nonroad engines to address issues that may arise concerning the importation of such engines. No significant air quality impact is expected from the amendments included in today's action.

Discussion of non-human health benefits of the rule: *2. Health and Welfare Effects of Tropospheric Ozone…Ozone also affects vegetation and ecosystems, leading to reductions in agricultural and commercial forest yields, reduced growth and survivability of tree seedlings, and increased plant susceptibility to disease, pests, and other environmental stresses (e.g., harsh weather). In long-lived species, these effects may become evident only after several years or even decades, thus having the potential for long-term effects on forest ecosystems. Ground-level ozone damage to the foliage of trees and other plants also can decrease the aesthetic value of ornamental species as well as the natural beauty of our national parks and recreation areas.*

Ozone chemically attacks elastomers (natural rubber and certain synthetic polymers), textile fibers and dyes, and, to a lesser extent, paints. For example, elastomers become brittle and crack, and dyes fade after exposure to ozone. Finally, by trapping energy radiated from the earth, tropospheric ozone may contribute to heating of the earth's surface via the ``greenhouse effect,'' thereby

contributing to global warming. Tropospheric ozone is also known to reduce levels of UVB radiation reaching the earth's surface."

Revisions to the Water Quality Planning and Management Regulation and Revisions to the National Pollutant Discharge Elimination System Program in Support of Revisions to the Water Quality Planning and Management Regulation, July 13, 2000, 65 FR 43586

SUMMARY: Today's final rule revises and clarifies the Environmental Protection Agency's (EPA) current regulatory requirements for establishing Total Maximum Daily Loads (TMDLs) under the Clean Water Act (CWA) so that TMDLs can more effectively contribute to improving the nation's water quality. Clean water has been a national goal for many decades. While significant progress has been made, particularly in stemming pollution from factories and city sewage systems, major challenges remain. These challenges call for a focused effort to identify polluted waters and enlist all those who enjoy, use, or depend on them in the restoration effort. Today's action will establish an effective and flexible framework to move the country toward the goal of clean water for all Americans. It establishes a process for making decisions in a common sense, cost effective way on how best to restore polluted waterbodies. It is based on identifying and implementing necessary reductions in both point and nonpoint sources of pollutants as expeditiously as practicable. States, Territories, and authorized Tribes will develop more comprehensive lists of all waterbodies that do not attain and maintain water quality standards. States, Territories, and authorized Tribes will schedule, based on priority factors, the establishment of all necessary TMDLs over 10 years, with an allowance for another five years where necessary. The rule also specifies elements of approvable TMDLs, including implementation plans which contain lists of actions and expeditious schedules to reduce pollutant loadings. States, Territories, and authorized Tribes will provide the public with opportunities to comment on methodologies, lists, prioritized schedules, and TMDLs prior to submission to EPA. The rule lays out specific timeframes under which EPA will assure that lists of waters and TMDLs are completed as scheduled, and necessary National Pollutant Discharge Elimination System (NPDES) permits are issued to implement TMDLs. The final rule explains EPA's discretionary authority to object to, and reissue if necessary, State-issued NPDES permits that have been administratively continued after expiration where there is a need for a change in the conditions of the permit to be consistent with water quality standards and established and approved TMDLs. EPA believes that these regulations are necessary because the TMDL program which Congress mandated in 1972 has brought about insufficient improvement in water quality. EPA had been concerned about this lack of progress for some time when, in 1996, it established a Federal Advisory Committee. The Committee was asked to advise EPA on possible improvements to the program. After careful deliberations, the Committee recommended that EPA amend several aspects of the regulations. EPA believes that these regulations will benefit human health and the environment by establishing clear goals for identification of impaired waterbodies

and establishment of TMDLs. The regulations will also ensure that States, Territories and authorized Tribes give a higher priority to restoring waterbodies which have a greater potential to affect human health or threatened or endangered species thereby focusing the benefits of these regulations on the most pressing problems.

Significant Final Rules in FY 2001

Control of Air Pollution From New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements; Final Rule 66 FR 5002

SUMMARY: The pollution emitted by diesel engines contributes greatly to our nation's continuing air quality problems. Even with more stringent heavy-duty highway engine standards set to take effect in 2004, these engines will continue to emit large amounts of nitrogen oxides and particulate matter, both of which contribute to serious public health problems in the United States. These problems include premature mortality, aggravation of respiratory and cardiovascular disease, aggravation of existing asthma, acute respiratory symptoms, chronic bronchitis, and decreased lung function. Numerous studies also link diesel exhaust to increased incidence of lung cancer. We believe that diesel exhaust is likely to be carcinogenic to humans by inhalation and that this cancer hazard exists for occupational and environmental levels of exposure.

We are establishing a comprehensive national control program that will regulate the heavy-duty vehicle and its fuel as a single system. As part of this program, new emission standards will begin to take effect in model year 2007, and will apply to heavy-duty highway engines and vehicles. These standards are based on the use of high-efficiency catalytic exhaust emission control devices or comparably effective advanced technologies. Because these devices are damaged by sulfur, we are also reducing the level of sulfur in highway diesel fuel significantly by mid-2006. The program provides substantial flexibility for refiners, especially small refiners, and for manufacturers of engines and vehicles. These options will ensure that there is widespread availability and supply of the low sulfur diesel fuel from the very beginning of the program, and will provide engine manufacturers with the lead time needed to efficiently phase-in the exhaust emission control technology that will be used to achieve the emissions benefits of the new standards.

We estimate that heavy-duty trucks and buses today account for about one-third of nitrogen oxides emissions and one-quarter of particulate matter emissions from mobile sources. In some urban areas, the contribution is even greater. This program will reduce particulate matter and oxides of nitrogen emissions from heavy duty engines by 90 percent and 95 percent below current standard levels, respectively. In order to meet these more stringent standards for diesel engines, the program calls for a 97 percent reduction in the sulfur content of diesel fuel. As a result, diesel vehicles will achieve gasoline-like exhaust emission levels. We are also finalizing more stringent standards for heavy-duty

gasoline vehicles, based in part on the use of the low sulfur gasoline that will be available when the standards go into effect. The clean air impact of this program will be dramatic when fully implemented. By 2030, this program will reduce annual emissions of nitrogen oxides, nonmethane hydrocarbons, and particulate matter by a projected 2.6 million, 115,000 and 109,000 tons, respectively. We project that these reductions and the resulting significant environmental benefits of this program will come at an average cost increase of about $2,000 to $3,200 per new vehicle in the near term and about $1,200 to $1,900 per new vehicle in the long term, depending on the vehicle size. In comparison, new vehicle prices today can range well over $100,000 for larger heavy-duty vehicles. We estimate that when fully implemented the sulfur reduction requirement will increase the cost of producing and distributing diesel fuel by about five cents per gallon.

Discussion of non-human health benefits of the rule: 7. Other Welfare and Environmental Effects Some commenters challenged the Agency's use of adverse welfare and environmental effects associated with emissions from heavy-duty vehicles as a partial basis for this rulemaking. Other commenters went to great lengths to support the Agency's inclusion of these welfare and environmental effects. Additional information has been added since the proposal in order to update and clarify the available information on welfare and environmental impacts of heavy-duty vehicle emissions. The following section presents information on four categories of public welfare and environmental impacts related to heavy-duty vehicle emissions: acid deposition, eutrophication of water bodies, POM deposition, and impairment of visibility.a. Acid Deposition Acid deposition, or acid rain as it is commonly known, occurs when SO2 and NOX react in the atmosphere with water, oxygen, and oxidants to form various acidic compounds that later fall to earth in the form of precipitation or dry deposition of acidic particles. (Much of the information in this subsection was excerpted from the EPA document, Human Health Benefits from Sulfate Reduction, written under Title IV of the 1990 Clean Air Act Amendments, U.S. EPA, Office of Air and Radiation, Acid Rain Division, Washington, DC 20460, November 1995. It contributes to damage of trees at high elevations and in extreme cases may cause lakes and streams to become so acidic that they cannot support aquatic life. In addition, acid deposition accelerates the decay of building materials and paints, including irreplaceable buildings, statues, and sculptures that are part of our nation's cultural heritage. To reduce damage to automotive paint caused by acid rain and acidic dry deposition, some manufacturers use acid-resistant paints, at an average cost of $5 per vehicle--a total of $61 million per year if applied to all new cars and trucks sold in the U.S

- Acid deposition primarily affects bodies of water that rest atop soil with a limited ability to neutralize acidic compounds. The National Surface Water Survey (NSWS) investigated the effects of acidic deposition in over 1,000 lakes larger than 10 acres and in thousands of miles of streams. It found that acid deposition was the primary cause of acidity in 75 percent of the acidic lakes and about 50 percent of the acidic streams, and that the areas most sensitive to acid rain were the Adirondacks, the mid-Appalachian highlands, the upper Midwest

and the high elevation West. The NSWS found that approximately 580 streams in the Mid-Atlantic Coastal Plain are acidic primarily due to acidic deposition. Hundreds of the lakes in the Adirondacks surveyed in the NSWS have acidity levels incompatible with the survival of sensitive fish species. Many of the over 1,350 acidic streams in the Mid-Atlantic Highlands (mid-Appalachia) region have already experienced trout losses due to increased stream acidity. Emissions from U.S. sources contribute to acidic deposition in eastern Canada, where the Canadian government has estimated that 14,000 lakes are acidic. Acid deposition also has been implicated in contributing to degradation of high-elevation spruce forests that populate the ridges of the Appalachian Mountains from Maine to Georgia. This area includes national parks such as the Shenandoah and Great Smoky Mountain National Parks.

A recent study of emissions trends and acidity of waterbodies in the Eastern United States by the General Accounting Office (GAO) found that sulfates declined in 92 percent of a representative sample of lakes from 1992 to 1999, and nitrate levels increased in 48 percent of the lakes sampled. (Acid Rain: Emissions Trends and Effects in the Eastern United States, US General Accounting Office, March, 2000 (GOA/RCED-00-47); Acid Deposition Standard Feasibility Study: Report to Congress, EPA 430R-95-001a, October, 1995.) The decrease in sulfates is consistent with emissions trends, but the increase in nitrates is inconsistent with the stable levels of nitrogen emissions and deposition. The study suggests that the vegetation and land surrounding these lakes have lost some of their previous capacity to use nitrogen, thus allowing more of the nitrogen to flow into the lakes and increase their acidity. Recovery of acidified lakes is expected to take a number of years, even where soil and vegetation have not been ``nitrogen saturated,'' as EPA called the phenomenon in a 1995 study.61 This situation places a premium on reductions of SOX and especially NOX from all sources, including HDVs, in order to reduce the extent and severity of nitrogen saturation and acidification of lakes in the Adirondacks and throughout the United States The SOX and NOX reductions from today's action will help reduce acid rain and acid deposition, thereby helping to reduce acidity levels in lakes and streams throughout the country and help accelerate the recovery of acidified lakes and streams and the revival of ecosystems adversely affected by acid deposition. Reduced acid deposition levels will also help reduce stress on forests, thereby accelerating reforestation efforts and improving timber production. Deterioration of our historic buildings and monuments, and of buildings, vehicles, and other structures exposed to acid rain and dry acid deposition also will be reduced, and the costs borne to prevent acid-related damage may also decline. While the reduction in sulfur and nitrogen acid deposition will be roughly proportional to the reduction in SOX and NOX emissions, respectively, the precise impact of today's action will differ across different areas.b. Eutrophication and Nitrification Eutrophication is the accelerated production of organic matter, particularly algae, in a water body. This increased growth can cause numerous adverse ecological effects and economic impacts, including nuisance algal blooms, dieback of underwater plants due to reduced light penetration, and toxic plankton blooms. Algal and plankton

blooms can also reduce the level of dissolved oxygen, which can also adversely affect fish and shellfish populations.

In 1999, NOAA published the results of a five year national assessment of the severity and extent of estuarine eutrophication. An estuary is defined as the inland arm of the sea that meets the mouth of a river. The 138 estuaries characterized in the study represent more than 90 percent of total estuarine water surface area and the total number of US estuaries. The study found that estuaries with moderate to high eutrophication conditions represented 65 percent of the estuarine surface area. Eutrophication is of particular concern in coastal areas with poor or stratified circulation patterns, such as the Chesapeake Bay, Long Island Sound, or the Gulf of Mexico. In such areas, the ``overproduced'' algae tends to sink to the bottom and decay, using all or most of the available oxygen and thereby reducing or eliminating populations of bottom-feeder fish and shellfish, distorting the normal population balance between different aquatic organisms, and in extreme cases causing dramatic fish kills.

Severe and persistent eutrophication often directly impacts human activities. For example, losses in the nation's fishery resources may be directly caused by fish kills associated with low dissolved oxygen and toxic blooms. Declines in tourism occur when low dissolved oxygen causes noxious smalls and floating mats of algal blooms create unfavorable aesthetic conditions. Risks to human health increase when the toxins from algal blooms accumulate in edible fish and shellfish, and when toxins become airborne, causing respiratory problems due to inhalation. According to the NOAA report, more than half of the nation's estuaries have moderate to high expressions of at least one of these symptoms--an indication that eutrophication is well developed in more than half of U.S. estuaries.

In recent decades, human activities have greatly accelerated nutrient inputs, such as nitrogen and phosphorous, causing excessive growth of algae and leading to degraded water quality and associated impairments of freshwater and estuarine resources for human uses. (Deposition of Air Pollutants to the Great Waters, Third Report to Congress, June, 2000.; Deposition of Air Pollutants to the Great Waters, Third Report to Congress, June, 2000.)Great Waters are defined as the Great Lakes, the Chesapeake Bay, Lake Champlain, and coastal waters. The first report to Congress was delivered in May, 1994; the second report to Congress in June, 1997.)

Since 1970, eutrophic conditions worsened in 48 estuaries and improved in 14. In 26 systems, there was no trend in overall eutrophication conditions since 1970. On the New England coast, for example, the number of red and brown tides and shellfish problems from nuisance and toxic plankton blooms have increased over the past two decades, a development thought to be linked to increased nitrogen loadings in coastal waters. Long-term monitoring in the United States, Europe, and other developed regions of the world shows a substantial rise of nitrogen levels in surface waters, which are highly correlated with human-generated inputs of nitrogen to their watersheds.

On a national basis, the most frequently recommended control strategies by experts surveyed by National Oceanic and Atmospheric Administration

(NOAA) between 1992-1997 were agriculture, wastewater treatment, urban runoff, and atmospheric deposition. In its Third Report to Congress on the Great Waters, EPA reported that atmospheric deposition contributes from 2 to 38 percent of the nitrogen load to certain coastal waters. (Deposition of Air Pollutants to the Great Waters, Third Report to Congress, June, 2000.) A review of peer reviewed literature in 1995 on the subject of air deposition suggests a typical contribution of 20 percent or higher.(Valigura, Richard, et al., Airsheds and Watersheds II: A Shared Resources Workshop, Air Subcommittee of the Chesapeake Bay Program, March, 1997.) Human-caused nitrogen loading to the Long Island Sound from the atmosphere was estimated at 14 percent by a collaboration of federal and state air and water agencies in 1997.(The Impact of Atmospheric Nitrogen Deposition on Long Island Sound, The Long Island Sound Study, September, 1997.) The National Exposure Research Laboratory, US EPA, estimated based on prior studies that 20 to 35 percent of the nitrogen loading to the Chesapeake Bay is attributable to atmospheric deposition.(Dennis, Robin L., Using the Regional Acid Deposition Model to Determine the Nitrogen Deposition Airshed of the Chesapeake Bay Watershed, SETAC Technical Publications Series, 1997.) The mobile source portion of atmospheric NOX contribution to the Chesapeake Bay was modeled at about 30 percent of total air deposition. (Dennis, Robin L., Using the Regional Acid Deposition Model to Determine the Nitrogen Deposition Airshed of the Chesapeake Bay Watershed, SETAC Technical Publications Series, 1997.)

Deposition of nitrogen from heavy-duty vehicles contributes to elevated nitrogen levels in waterbodies. In the Chesapeake Bay region, modeling shows that mobile source deposition occurs in relatively close proximity to highways, such as the 1-95 corridor which covers part of the Bay surface. The new standards for heavy-duty vehicles will reduce total NOX emissions by 2.6 million tons in 2030. The NOX reductions will reduce the airborne nitrogen deposition that contributes to eutrophication of watersheds, particularly in aquatic systems where atmospheric deposition of nitrogen represents a significant portion of total nitrogen loadings.c. Polycyclic Organic Matter Deposition EPA's Great Waters Program has identified 15 pollutants whose deposition to water bodies has contributed to the overall contamination loadings to the these Great Waters. (Deposition of Air Pollutants to the Great Waters--Third Report to Congress, June, 2000, Office of Air Quality Planning and Standards Deposition of Air Pollutants to the Great Waters--Second Report to Congress, Office of Air Quality Planning and Standards, June 1997, EPA-453/R-97-011.) One of these 15 pollutants, a group known as polycyclic organic matter (POM), are compounds that are mainly adhered to the particles emitted by mobile sources and later fall to earth in the form of precipitation or dry deposition of particles. The mobile source contribution of the 7 most toxic POM is at least 62 tons/year and represents only those POM that adhere to mobile source particulate emissions.

Combustion Sources at Kraft, Soda, Sulfite, and Stand-Alone Semichemical Pulp Mills; Final Rule 66 FR 3180

SUMMARY: This action promulgates national emission standards for hazardous air pollutants (NESHAP) for new and existing sources used in chemical recovery processes at kraft, soda, sulfite, and stand-alone semichemical pulp mills. Hazardous air pollutants (HAP) that are regulated by this final rule include gaseous organic HAP and HAP metals. The adverse health effects of exposure to these HAP can include cancer, reproductive and developmental effects, gastrointestinal effects, damage to the nervous system, and irritation to the eyes, skin, and respiratory system. Emissions of other pollutants from these sources include particulate matter (PM), volatile organic compounds (VOC), carbon monoxide (CO), sulfur dioxide (SO2), and nitrogen oxides (NOX).

This final rule implements section 112(d) of the Clean Air Act (CAA) and is based on the Administrator's determination that chemical recovery combustion sources at kraft, soda, sulfite, and stand-alone semichemical pulp mills are major sources of HAP emissions. The final rule is intended to protect public health by requiring chemical recovery combustion sources to meet standards reflecting the application of the maximum achievable control technology (MACT) to control HAP emissions from these sources. Implementation of this rule will reduce emissions of HAP by approximately 2,500 megagrams per year (Mg/yr) (2,700 tons per year (tpy)) and emissions of other pollutants by approximately 107,900 Mg/yr (118,900 tpy).

Discussion of non-human health benefits of the rule: "Implementation of today's final rule is expected to reduce emissions of HAP, PM, VOC, CO, and SO2, while it is expected to slightly increase emissions of NOX. Such pollutants can potentially cause adverse health effects and can have welfare effects, such as impaired visibility and reduced crop yields. In the benefits analysis, we have not conducted detailed air quality modeling to evaluate the magnitude and extent of the potential impacts from individual pulp and paper facilities. Nevertheless, to the extent that emissions from these facilities cause adverse effects, this final rule would mitigate such impacts.

1. Qualitative Description of Pollutant Effects

This final rule is designed to reduce the emissions of HAP, as defined in section 112 of the CAA. Several of these HAP are classified as known, probable, or possible human carcinogens. They have also been shown to cause other adverse health effects, such as damage to the eye, central nervous system, liver, kidney, and respiratory system depending upon the exposures to these emissions. The types of studies in which these various effects have been reported include: (1) Epidemiological studies of health effects occurring in human populations (e.g., the general population, or workers exposed in the workplace), (2) case reports that document human exposure incidents (e.g., accidental releases or poisonings), (3) carefully controlled laboratory exposures of volunteer human subjects, and (4) laboratory studies on animals. Emissions of VOC and NOX interact in the presence of sunlight to create ground-level ozone. Recent scientific evidence shows an association between elevated ozone concentrations and increases in hospital admissions for a variety of respiratory illnesses and indicates that ground-level ozone not only affects people with impaired respiratory systems

(such as asthmatics), but healthy adults and children as well. Adverse welfare effects of ozone exposure include damage to crops, tree seedlings, ornamentals (shrubs, grass, etc.), and forested ecosystems. The reactions between VOC and NOX to form ozone depend on the balance in concentrations of each pollutant found in the ambient air. For example, when the concentration of NOX is high relative to the concentration of VOC, VOC reductions are effective in limiting ozone formation, while NOX reductions in that situation are ineffective. This rule is expected to increase NOX emissions slightly, but also decrease VOC emissions. The increase in NOX under this rule is not expected to cause significant adverse health or welfare impacts because the magnitude of the NOX increase (less than 500 Mg/yr) is very small relative to the total NOX inventory.

The VOC emission reductions from this rule occur primarily in rural attainment areas. These areas tend to be NOX limited; therefore, VOC reductions are not expected to affect ozone concentrations. The low-end estimate of VOC benefits relates to emissions reductions (3,400 Mg/yr) occurring in ozone nonattainment areas. Since ozone nonattainment areas are typically urban areas that are VOC limited, these emissions reductions are likely to be effective in limiting ozone formation. The high-end of the range of VOC benefits includes all VOC emissions reductions (31,000 Mg/yr) expected to occur for this rule. This estimate is included to account for the uncertainty as to whether specific rural areas are NOX limited.

Exposure to PM has been associated with the following adverse human health effects: Premature mortality, aggravation of respiratory and cardiovascular disease, changes in lung function and increased respiratory symptoms, alterations in lung tissue and structure, and altered respiratory tract defense mechanisms. In general, exposed populations at greater risk from these effects are the following: individuals with respiratory disease and cardiovascular disease, individuals with infectious disease, elderly individuals, asthmatic individuals, and children. Reduced welfare is associated with elevated concentrations of fine particles, which reduce visibility, damage materials, and cause soiling. The reductions in PM emissions under this rule (approximately 21,000 Mg/yr) are intended to decrease the adverse effects of PM, to the extent that populations or scenic destinations are located within pollutant transport distance of pulp and paper facilities.

Carbon monoxide is a colorless, odorless gas that is toxic to mammals. When inhaled, it combines with hemoglobin, which reduces the oxygen-carrying capacity of blood and results in less oxygen being transported to vital organs of the body. This can have detrimental effects on the cardiovascular and central nervous systems. There are numerous studies that support the association between ambient CO levels and adverse health effects which have been cited in the Air Quality Criteria Document for Carbon Monoxide (EPA Document No. 600/P-99/001F, June 2000). The reduction of[[Page 3190]]CO emissions under this rule is intended to diminish these potential effects. Sulfur dioxide oxidizes in water to form both sulfurous and sulfuric acids. When SO2 dissolves in the atmosphere in rain, fog, or snow, the acidity of the deposition can corrode various materials and cause damage to both aquatic and terrestrial ecosystems.

Sulfur dioxide can also transform into PM2.5, (i.e., particulate matter with an aerodynamic diameter less than or equal to 2.5 micrometers). Emissions of SO2 are reduced slightly (20 Mg/yr) under this rule.2. Monetized Air Quality Benefits We used a benefit transfer method to value a subset of the emissions reductions for the MACT II rule. Monetized benefit values are estimated for only VOC, SO2, and PM emissions reductions expected to result from this rule. This method relies on a benefits analysis conducted for the Ozone and PM national ambient air quality standards (NAAQS). The benefits analysis conducted for the NAAQS involves the same pollutants that are impacted by this pulp and paper rulemaking, and we assume the values from the NAAQS analysis are applicable to this final rule. The NAAQS analysis valued the national-level benefits achieved from a single, ``representative'' year under a new set of standards. The benefits (in dollars) per ton of reduction of each pollutant were then applied to the projected reductions of the same pollutants under this final rule.

We assume that the relationship of emission changes with the health and welfare effects associated with the NAAQS-estimated ozone and PM concentrations correspond to the projected changes in emissions from pulp and paper mills. No air quality modeling was conducted to evaluate potential changes in human exposure under the rule, so the actual magnitude and timing of human health benefits are unknown. In some cases, we did consider the location of mills when applying the NAAQS benefits per ton figures. For VOC monetized benefits, a low-end estimate included emissions only in ozone nonattainment areas, which was compared to a high-end estimate that used all VOC emissions. For SO2, the benefit transfer values differed between mills located in the eastern and western portions of the United States. Some benefit categories were not monetized at all, due to a lack of sufficient data. Nevertheless, the largest monetized benefits are derived from PM reductions, for which we used nationwide emission estimates and assume that the distributions of exposed populations from the ozone and PM studies are similar to those exposed to pulp and paper mill emissions. The EPA estimates that the rule would reduce HAP emissions by approximately 2,500 Mg/yr; VOC emissions by approximately 31,000 Mg/yr (3,400 Mg/yr in ozone nonattainment areas); CO emissions by 56,000 Mg/yr; PM emissions by approximately 21,000 Mg/yr; and SO2 emissions by 20 Mg/yr; and increase NOX emissions by approximately 500 Mg/yr. Based upon the previously discussed emissions reductions, we estimate that the monetary benefits of the rule range between $280 million and $370 million (1997$) for a representative year.

This rule is expected to result in reductions in PM emissions for particles of varying sizes. We expect most PM reductions to be in the size range of PM10 and below. This assumption is based upon the fact that existing chemical recovery process sources typically have PM controls in place which have removed most of the large particles associated with uncontrolled emissions. However, it is likely that a small fraction of emissions reductions will be for particles above PM10. Reductions in emissions of particle sizes greater than 10 micrometers may not result in the same benefits as particles of sizes less than 10 micrometers. As such, PM-related benefits reported for this rule represent an upper-bound estimate on the applicable PM emissions reductions.

These figures suggest that the benefits of today's final rule may be significantly greater than the projected costs. Chapter 4 of the EA presents a detailed description of the methodology used to monetize the benefits of the rule."

Significant Final Rules in FY 2002

Control of Emissions From Nonroad Large Spark-Ignition Engines, and Recreational Engines (Marine and Land-Based); Final Rule 67 FR 72821

SUMMARY: In this action, we are adopting emission standards for several groups of nonroad engines that have not been subject to EPA emission standards. These engines are large spark-ignition engines such as those used in forklifts and airport ground-service equipment; recreational vehicles using spark-ignition engines such as off-highway motorcycles, all-terrain vehicles, and snowmobiles; and recreational marine diesel engines. Nationwide, these engines and vehicles cause or contribute to ozone, carbon-monoxide, and particulate-matter nonattainment, as well as other types of pollution impacting human health and welfare.

We expect that manufacturers will be able to maintain or even improve the performance of their products when producing engines and equipment meeting the new standards. Many engines will substantially reduce their fuel consumption, partially or completely offsetting any costs associated with the emission standards. Overall, the gasoline-equivalent fuel savings associated with the anticipated changes in technology resulting from this rule are estimated to be about 800 million gallons per year once the program is fully phased in. Health and environmental benefits from the controls included in today's rule are estimated to be approximately $8 billion per year once the controls are fully phased in. There are also several provisions to address the unique limitations of small-volume manufacturers.

Discussion of non-human health benefits of the rule: Emissions from the engines regulated in this rule contribute to serious air-pollution problems, and will continue to do so in the future absent regulation. These air pollution problems include exposure to carbon monoxide (CO), ground-level ozone, and particulate matter (PM), which can cause serious health problems, including premature mortality and respiratory problems. Fine PM has also been associated with cardiovascular problems, such as heart rate variability and changes in fibrinogen (a blood clotting factor) levels, and hospital admissions and mortality related to cardiovascular diseases. These emissions also contribute to other serious environmental problems, including visibility impairment and ecosystem damage. In addition, many of the hydrocarbon (HC) pollutants emitted by these engines are air toxics.

Visibility Impairment in Class I Areas. The Clean Air Act establishes special goals for improving visibility in many national parks, wilderness areas, and international parks. In the 1977 amendments to the Clean Air Act, Congress

set as a national goal for visibility the ``prevention of any future, and the remedying of any existing, impairment of visibility in mandatory class I Federal areas which impairment results from manmade air pollution'' (CAA section 169A(a)(1)). The Amendments called for EPA to issue regulations requiring States to develop implementation plans that assure ``reasonable progress'' toward meeting the national goal (CAA Section 169A(a)(4)). EPA issued regulations in 1980 to address visibility problems that are ``reasonably attributable'' to a single source or small group of sources, but deferred action on regulations related to regional haze, a type of visibility impairment that is caused by the emission of air pollutants by numerous emission sources located across a broad geographic region. At that time, EPA acknowledged that the regulations were only the first phase for addressing visibility impairment. Regulations dealing with regional haze were deferred until improved techniques were developed for monitoring, for air quality modeling, and for understanding the specific pollutants contributing to regional haze.

In the 1990 Clean Air Act amendments, Congress provided additional emphasis on regional haze issues (see CAA section 169B). In 1999 EPA finalized a rule that calls for States to establish goals and emission reduction strategies for improving visibility in all 156 mandatory Class I national parks and wilderness areas. In this rule, EPA established a ``natural visibility'' goal. In that rule, EPA also encouraged the States to work together in developing and implementing their air quality plans. The regional haze program is focused on long-term emissions decreases from the entire regional emissions inventory comprised of major and minor stationary sources, area sources and mobile sources. The regional haze program is designed to improve visibility and air quality in our most treasured natural areas from these broad sources. At the same time, control strategies designed to improve visibility in the national parks and wilderness areas will improve visibility over broad geographic areas. In the 1997 PM NAAQS rulemaking, EPA also anticipated the need in addition to the NAAQS and Section 169 regional haze program to continue to address localized impairment that may relate to unique circumstances in some Western areas. For mobile sources, there is a need for a Federal role in reduction of those emissions, particularly because mobile source vehicles are regulated primarily at the federal level.

Visibility impairment is caused by pollutants (mostly fine particles and precursor gases) directly emitted to the atmosphere by several activities (such as electric power generation, various industry and manufacturing processes, truck and auto emissions, construction activities, etc.). These gases and particles scatter and absorb light, removing it from the sight path and creating a hazy condition. Visibility impairment is caused by both regional haze and localized impairment. As described above, regional haze is causedby the emission from numerous sources located over a wide geographic area.(U.S. EPA Review of the National Ambient Air Quality Standards for Particulate Matter: Policy Assessment of Scientific and Technical Information OAQPS Staff Paper. EPA-452/R-96-013. 1996. Docket Number A-99-06, Documents Nos. II-A-18, 19, 20, and 23. The particulate matter air quality criteria documents are also available at http://www.epa.gov/ncea/partmatt.htm).

Significant Final Rules in FY 2003

National Pollutant Discharge Elimination System Permit Regulation and Effluent Limitation Guidelines and Standards for Concentrated Animal Feeding Operations (CAFOs) 68 FR 7176

SUMMARY: Today's final rule revises and clarifies the Environmental Protection Agency's (EPA) regulatory requirements for concentrated animal feeding operations (CAFOs) under the Clean Water Act. This final rule will ensure that CAFOs take appropriate actions to manage manure effectively in order to protect the nation's water quality.

Despite substantial improvements in the nation's water quality since the inception of the Clean Water Act, nearly 40 percent of the Nation's assessed waters show impairments from a wide range of sources. Improper management of manure from CAFOs is among the many contributors to remaining water quality problems. Improperly managed manure has caused serious acute and chronic water quality problems throughout the United States.

Today's action strengthens the existing regulatory program for CAFOs. The rule revises two sections of the Code of Federal Regulations (CFR), the National Pollutant Discharge Elimination System (NPDES) permitting requirements for CAFOs (Sec. 122) and the Effluent Limitations Guidelines and Standards (ELGs) for CAFOs (Sec. 412).

The rule establishes a mandatory duty for all CAFOs to apply for an NPDES permit and to develop and implement a nutrient management plan. The effluent guidelines being finalized today establish performance expectations for existing and new sources to ensure appropriate storage of manure, as well as expectations for proper land application practices at the CAFO. The required nutrient management plan would identify the site-specific actions to be taken by the CAFO to ensure proper and effective manure and wastewater management, including compliance with the Effluent Limitation Guidelines. Both sections of the rule also contain new regulatory requirements for dry-litter chicken operations.

This improved regulatory program is also designed to support and complement the array of voluntary and other programs implemented by the United States Department of Agriculture (USDA), EPA and the States that help the vast majority of smaller animal feeding operations not addressed by this rule. This rule is an integral part of an overall federal strategy to support a vibrant agriculture economy while at the same time taking important steps to ensure that all animal feeding operations manage their manure properly and protect water quality.

EPA believes that these regulations will substantially benefit human health and the environment by assuring that an estimated 15,500 CAFOs effectively manage the 300 million tons of manure that they produce annually. The rule also acknowledges the States' flexibility and range of tools to assist small and medium-size AFOs.

Appendix B: Executive Order 12866 on *Regulatory Planning And Review,* dated September 10, 1993

EXECUTIVE ORDER — EO 12866
Effective Date September 30, 1993

Responsible Office: JM

Subject: REGULATORY PLANNING AND REVIEW

TEXT

The American people deserve a regulatory system that works for them, not against them: a regulatory system that protects and improves their health, safety, environment, and well-being and improves the performance of the economy without imposing unacceptable or unreasonable costs on society; regulatory policies that recognize that the private sector and private markets are the best engine for economic growth; regulatory approaches that respect the role of State, local, and tribal governments; and regulations that are effective, consistent, sensible, and understandable. We do not have such a regulatory system today.

With this Executive order, the Federal Government begins a program to reform and make more efficient the regulatory process. The objectives of this Executive order are to enhance planning and coordination with respect to both new and existing regulations; to reaffirm the primacy of Federal agencies in the regulatory decision-making process; to restore the integrity and legitimacy or regulatory review and oversight; and to make the process more accessible and open to the public. In pursuing these objectives, the regulatory process shall be conducted so as to meet applicable statutory requirements and with due regard to the discretion that has been entrusted to the Federal agencies.

Accordingly, by the authority vested in me as President by the Constitution and the laws of the United States of America, it is hereby ordered as follows:

Section 1. Statement of Regulatory Philosophy and Principles. (a) The Regulatory Philosophy. Federal agencies should promulgate only such regulations as are required by law, are necessary to interpret the law, or are made necessary by compelling public need, such as material failures of private markets to protect or improve the health and safety of the public, the environment, or the well-being of the American people. In deciding whether and how to regulate, agencies should assess all costs and benefits of available regulatory alternatives, including the alternative of not regulating. Costs and benefits shall be understood to include both quantifiable measures (to the fullest extent that these can be usefully estimated) and qualitative measures of costs and benefits that are difficult to quantify, but nevertheless essential to

consider. Further, in choosing among alternative regulatory approaches, agencies should select those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages, distributive impacts; and equity), unless a statute requires another regulatory approach.

(b) The Principles of Regulation. To ensure that the agencies' regulatory programs are consistent with the philosophy set forth above, agencies should adhere to the following principles, to the extent permitted by law and where applicable:

(1) Each agency shall identify the problem that it intends to address (including, where applicable, the failures of private markets or public institutions that warrant new agency action) as well as assess the significance of that problem.

(2) Each agency shall examine whether existing regulations (or other law) have created, or contributed to, the problem that a new regulation is intended to correct and whether those regulations (or other law) should be modified to achieve the intended goal of regulation more effectively.

(3) Each agency shall identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public.

(4) In setting regulatory priorities, each agency shall consider, to the extent reasonable, the degree and nature of the risks posed by various substances or activities within its jurisdiction.

(5) When an agency determines that a regulation is the best available method of achieving the regulatory objective, it shall design its regulations in the most cost-effective manner to achieve the regulatory objective. In doing so, each agency shall consider incentives for innovation, consistency, predictability, the costs of enforcement and compliance (to the government, regulated entities, and the public), flexibility, distributive impacts, and equity.

(6) Each agency shall assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs.

(7) Each agency shall base its decisions on the best reasonably obtainable scientific, technical, economic, and other information concerning the need for, and consequences of, the intended regulation.

(8) Each agency shall identify and assess alternative forms of regulation and shall, to the extent feasible, specify

performance objectives, rather than specifying the behavior or manner of compliance that required entities must adopt.

(9) Wherever feasible, agencies shall seek views of appropriate State, local, and tribal officials before imposing regulatory requirements that might significantly or uniquely affect those governmental entities. Each agency shall assess the effects of Federal regulations on State, local, and tribal governments, including specifically the availability of resources to carry out those mandates, and seek to minimize those burdens that uniquely or significantly affect such governmental entities, consistent with achieving regulatory objectives. In addition, as appropriate, agencies shall seek to harmonize Federal regulatory actions with related State, local, and tribal regulatory and other governmental functions.

(11) Each agency shall tailor its regulations to impose the least burden on society, including individuals, businesses of differing sizes, and other entities (including small communities and government entities), consistent with obtaining the regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations.

(12) Each agency shall draft its regulations to be simple and easy to understand, with the goal of minimizing the potential for uncertainty and litigation arising from such uncertainty.

Sec. 2. Organization. An efficient regulatory planning and review process is vital to ensure that the Federal Government's regulatory system best serves the American people.

(a) The Agencies. Because Federal agencies are the repositories of significant substantive expertise and experience, they are responsible for developing regulations and assuring that the regulations are consistent with applicable law, the President's priorities, and the principles set forth in this Executive order.

(b) The Office of Management and Budget. Coordinated review of agency rulemaking is necessary to ensure that regulations are consistent with applicable law, the President's priorities, and the principles set forth in this Executive order, and that decisions made by one agency do not conflict with the policies or actions taken or planned by another agency. The Office of Management and Budget (OMB) shall carry out that review function. Within OMB, the Office of Information and Regulatory Affairs (OIRA) is the repository of expertise concerning regulatory issues, including methodologies and procedures that affect more than one agency, this Executive order, and the President's regulatory policies. To the extent permitted by law, OMB shall provide guidance to agencies and assist the President, the Vice President, and other regulatory policy advisors to the President in regulatory planning and shall be the entity that reviews individual regulations, as provided by this Executive order.

(c) The Vice President. The Vice President is the principal advisor to the President on, and shall coordinate the development and presentation of recommendations concerning, policy, planning, and review, as set forth in this Executive order. In fulfilling their responsibilities under this Executive order, the President and the Vice President shall be assisted by the regulatory policy advisors within the Executive Office of the President and by such agency officials and personnel as the President and the Vice President may, from time to time, consult.

Sec. 3. Definitions. For purposes of this Executive order: (a) "Advisors" refers to such regulatory policy advisors to the President as the President and Vice President may from time to time consult, including, among others: (1) the Director of OMB; (2) the Chair (or another member) of the Council of Economic Advisers; (3) the Assistant to the President for Economic Policy; (4) the Assistant to the President for Domestic Policy; (5) the Assistant to the President for National Security Affairs; (6) the Assistant to the President for Science and Technology; (7) the Assistant to the President for Intergovernmental Affairs; (8) the Assistant to the President and Staff Secretary; (9) the Assistant to the President and Chief of Staff to the Vice President; (10) the Assistant to the President and Counsel to the President; (11) the Deputy Assistant to the President and Director of the White House Office on Environmental Policy; and (12) the Administrator of OIRA, who also shall coordinate communication relating to this Executive order among the agencies, OMB, the other Advisors, and the Office of the Vice President.

(b) "Agency," unless otherwise indicated, means any authority of the United States is an "agency" under 44 U.S.C. 3502(1), other than those considered to be independent regulatory agencies, as defined in 44 U.S.C. 3502(10).

(c) "Director" means the Director of OMB.

(d) "Regulation" or "rule" means an agency statement of general applicability and future effect, which the agency intends to have the force and effect of law, that is designed to implement, interpret, or prescribe law or policy or to describe the procedure or practice requirements of an agency. It does not however, include:

(1) Regulations or rules issued in accordance with the formal rulemaking provisions of 5 U.S.C. 556, 557;

(2) Regulations or rules that pertain to a military or foreign affairs function of the United States, other than procurement regulations and regulations involving the import or export of non-defense articles and services;

(3) Regulations or rules that are limited to agency organization, management, or personnel matters; or

(4) Any other category of regulations exempted by the

Administrator of OIRA.

(e) "Regulatory action" means any substantive action by an agency (normally published in the Federal Register) that promulgates or is expected to lead to the promulgation of a final rule or regulation, including notices or inquiry, advance notices of proposed rulemaking, and notices of proposed rulemaking.

(f) "Significant regulatory action" means any regulatory action that is likely to result in a rule that may:

(1) Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities;

(2) Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;

(3) Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or

(4) Raise novel legal or policy issues arising out of legal mandates, the President priorities, or the principles set forth in this Executive order.

Sec. 4. Planning Mechanism. In order to have an effective regulatory program, to provide for coordination of regulations, to maximize consultation and the resolution of potential conflicts at an early stage, to involve the public and its State, local, and tribal officials in regulatory planning, and to ensure that new or revised regulations promote the President's priorities and the principles set forth in this Executive order, these procedures shall be followed, to the extent permitted by law: (a) Agencies' Policy Meeting. Early in each year's planning cycle, the Vice President shall convene a meeting of the Advisors and the heads of agencies to seek a common understanding of priorities and to coordinate regulatory efforts to be accomplished in the upcoming year.

(b) Unified Regulatory Agenda. For purposes of this subsection the term "agency" or "agencies" shall also include those considered to be independent regulatory agencies, as defined in 44 U.S.C. 3502(10). Each agency shall prepare an agenda of all regulations under development or review, at a time and in a manner specified by the Administrator OIRA. The description of each regulatory action shall contain, at a minimum, a regulation identifier number, a brief summary of the action, the legal authority for the action, any legal deadline for the action, and the name and telephone number of a knowledgeable agency official. Agencies may incorporate the information required under 5 U.S.C. 602 and 41 U.S.C. 402 into these agendas.

(c) The Regulatory Plan. For purposes of this subsection, the term "agency" or "agencies" shall also include those considered to be independent regulatory agencies, as defined in 44 U.S.C. 3502(10). (1) As part of the United Regulatory Agenda, beginning in 1994, each agency shall prepare a Regulatory Plan (Plan) of the most important significant regulatory actions that the agency reasonably expects to issue in proposed or final form in that fiscal year or thereafter. The Plan shall be approved personally by the agency head and shall contain at a minimum:

(A) A statement of the agency's regulatory objectives and priorities and how they relate to the President's priorities;

(B) A summary of each planned significant regulatory action including, to the extent possible, alternatives to be considered and preliminary estimates of the anticipated costs and benefits;

(C) A summary of the legal basis for each such action, including whether any aspect of the action is required by statue or court order;

(D) A statement of the need for each such action and, if applicable how the action will reduce risks to public health, safety, or the environment, as well as how the magnitude of the risk addressed by the action relates to other risks within the jurisdiction of the agency;

(E) The agency's schedule for action, including a statement of any applicable statutory or judicial deadlines; and

(F) The name, address, and telephone number of a person the public may contact for additional information about the planned regulatory action.

(2) Each agency shall forward its Plan to OIRA by June 1st of each year.

(3) Within 10 calendar days after OIRA has received an agency's Plan, OIRA shall circulate it to other affected agencies, the Advisors, and the Vice President.

(4) An agency head who believes that a planned regulatory action of another agency may conflict with its own policy or action taken or planned shall promptly notify, in writing, the Administrator of OIRA, who shall forward that communication to the issuing agency, the Advisors, and the Advisors, and the Vice President.

(5) If the Administrator of OIRA believes that a planned regulatory action of an agency may be inconsistent with the President's priorities or the principles set forth in this Executive order or may be in conflict with any policy or action taken or planned by another agency, the Administrator of OIRA shall promptly notify, in writing, the affected agencies, the Advisors, and the Vice President.

(6) The Vice President, with the Advisors' assistance, may consult with the heads of agencies with respect to their Plans and, in appropriate instances, request further consideration or interagency coordination.

(7) The Plans developed by the issuing agency shall be published annually in the October publication of the United Regulatory Agenda. This publication shall be made available to the Congress; State, local, and tribal governments; and the public. Any views on any aspect of any agency Plan, including whether any planned regulatory action might conflict with any other planned or existing regulation, impose any unintended consequences on the public, or confer any unclaimed benefits on the public, should be directed to the issuing agency, with a copy to OIRA.

(d) Regulatory Working Group. Within 30 days of the date of this Executive order, the Administrator of OIRA shall convene a Regulatory Working Group ("Working Group"), which shall consist of representatives of the heads of each agency that the Administrator determines to have significant domestic regulatory responsibility, the Advisors, and the Vice President. The Administrator of OIRA shall chair the Working Group and shall periodically advise the vice President on the activities of the Working Group. The Working Group shall serve as a forum to assist agencies in identifying and analyzing important regulatory issues (including, among others (1) the development of innovative regulatory techniques, (2) the methods, efficacy, and utility of comparative risk assessment in regulatory decision-making, and (3) the development of short forms and other streamlined regulatory approaches for small businesses and other entities). The Working Group shall meet at least quarterly and may meet as a whole or in subgroups of agencies with an interest in particular issues or subject areas. To inform its discussions, the Working Group may commission analytical studies and reports by OIRA, the Administrative Conference of the United States, or any other agency.

(e) Conferences. The Administrator of OIRA shall meet quarterly with representatives of State, local, and tribal governments to identify both existing and proposed regulations that may uniquely or significantly affect those governmental entitities. The Administrator of OIRA shall also convene, from time to time, conferences with representatives of businesses, nongovernmental organizations, and the public to discuss regulatory issues of common concern.

Sec. 5. Existing Regulations. In order to reduce the regulatory burden on the American people, their families, their communities, their State, local, and tribal governments, and their industries; to determine whether regulations promulgated by the executive branch of the Federal Governments have become unjustified or unnecessary as a result of changed circumstances; to confirm that regulations are both compatible with each other and not duplicative or inappropriately burdensome in the aggregate; to

ensure that all regulations are consistent with the President's priorities and the principles set forth in this Executive order, within applicable law; and to otherwise improve the effectiveness of existing regulations: (a) Within 90 days of the date of this Executive order, each agency shall submit to OIRA a program, consistent with its resources and regulatory priorities, under which the agency will periodically review its existing significant regulations to determine whether any such regulations should be modified or eliminated so as to make the agency's regulatory program more effective in achieving the regulatory objectives, less burdensome, or in greater alignment with the President's priorities and the principles set forth in this Executive order. Any significant regulations selected for review shall be included in the agency's annual Plan. The agency shall also identify any legislative mandates that require the agency to promulgate or continue to impose regulations that the agency believes are unnecessary or outdated by reason of changed circumstances.

(b) The Administrator of OIRA shall work with the Regulatory Working Group and other interested entities to pursue the objectives of this section State, local, and tribal governments are specifically encouraged to assist in the identification of regulations that impose significant or unique burdens on those government entities and that appear to have outlived their justification or be otherwise inconsistent with the public interest.

(c) The Vice President, in consultation with the Advisors, may identify for review by the appropriate agency or agencies other existing regulations of an agency or groups of regulations of more than one agency that affect a particular group, industry, or sector of the economy, or may identify legislative mandates that may be appropriate for reconsideration by the Congress.

Sec. 6. Centralized Review of Regulations. The guidelines set forth below shall apply to all regulatory actions, for both new and existing regulations, by agencies other than those agencies specifically exempted by the Administrator of OIRA:

(a) Agency Responsibilities. (1) Each agency shall (consistent with its own rules, regulations, or procedures) provide the public with meaningful participation in the regulatory process. In particular, before issuing a notice of proposed rulemaking, each agency should, where appropriate, seek the involvement of those who are intended to benefit from and those expected to be burdened by any regulation (including, specifically, State, local, and tribal officials). In addition, each agency should afford the public a meaningful opportunity to comment on any proposed regulation, which in most cases should include a comment period of not less than 60 days. Each agency also is directed to explore and, where appropriate, use consensual mechanisms for developing regulations, including negotiated rulemaking.

(2) Within 60 days of the date of this Executive order,

each agency head shall designate a Regulatory Policy Officer who shall report to the agency head. The Regulatory Policy Officer shall be involved at each stage of the regulatory process to foster the development of effective, innovative, and least burdensome regulations and to further the principles set forth in this Executive order.

(3) In addition to adhering to its own rules and procedures and to the requirements of the Administrative Procedure Act, the Regulatory Flexibility Act, the Paperwork Reduction Act, and other applicable law, each agency shall develop its regulatory actions in a timely fashion and adhere to the following procedures with respect to a regulatory action:

(A) Each agency shall provide OIRA, at such times and in the manner specified by the Administrator of OIRA, with a list of its planned regulatory actions, indicating those which the agency believes are significant regulatory actions with the meaning of this Executive order. Absent a material change in the development of the planned regulatory action, those not designated as significant will not be subject to review under this section unless, within 10 working days of receipt of the list, the Administrator of OIRA notifies the agency that OIRA has determined that a planned regulation is a significant regulatory action within the meaning of this Executive order. The Administrator of OIRA may waive review of any planned regulatory action designated by the agency as significant, in which case the agency need not further comply with subsection (a)(3)(B) or subsection (a)(3)(C) of this section.

(B) For each matter identified as, or determined by the Administrator of OIRA to be, a significantly regulatory action, the issuing agency shall provide to OIRA:

(i) The text of the draft regulatory action together with a reasonably detailed description of the need for the regulatory action and an explanation of how the regulatory action will meet that need; and

(ii) An assessment of the potential costs and benefits of the regulatory action, including an explanation of the manner in which the regulatory action is consistent with a statutory mandate and, to the extent permitted by law, promotes the President's priorities and avoids undue interference with State, local, and tribal governments in the exercise of their governmental functions.

(C) For those matters identified as, or determined by the Administrator of OIRA to be, a significant regulatory action within the scope of section 3(f)(1), the agency shall also provide the OIRA the following additional information developed as part of the agency's decision-making process (unless prohibited by law):

(i) An assessment, including the underlying analysis, of benefits anticipated from the regulatory action (such ac, but not

limited to, the promotion of the efficient functioning of the economy and private markets, the enhancement of health and safety, the protection of the natural environment, and the elimination or reduction of discrimination or bias) together with, to the extent feasible, a quantification of those benefits;

(ii) An assessment, including the underlying analysis, of costs anticipated from the regulatory action (such as, but not limited to, the direct cost both to the government in administering the regulation and to businesses and others in complying with the regulation, and any adverse effects on the efficient functioning of the economy, private markets (including productivity, employment, and competitiveness), health, safety, and the natural environment), together with, to the extent feasible, a quantification of those costs; and

(iii) An assessment, including the underlying analysis, of costs and benefits of potentially effective and reasonably feasible alternatives to the planned regulation, identified by the agencies or the public (including improving the current regulation and reasonably viable nonregulatory actions), and an explanation why the planned regulatory action is preferable to the identified potential alternatives.

(D) In emergency situations or when an agency is obligated by law to act more quickly than normal review procedures allow, the agency shall notify OIRA as soon as possible and, to the extent practicable, comply with subsections (a)(3)(B) and (C) of this section. For those regulatory actions that are governed by a statutory or court-imposed deadline, the agency shall, to the extent practicable, schedule rulemaking proceedings so as to permit sufficient time for OIRA to conduct its review, as set forth below in subsection (b)(2) through (2) through (4) of this section.

(E) After the regulatory action has been published in the Federal Register or otherwise issued to the public, the agency shall:

(i) Make available to the public the information set forth in subsections (a)(3)(B) and (C);

(ii) Identify for the public, in a complete, clear, and simple manner, the substantive changes between the draft submitted to OIRA for review and the action subsequently announced; and

(iii) Identify for the public those changes in the regulatory action that were made at the suggestion or recommendation of OIRA.

(F) All information provided to the public by the agency shall be in plain, understandable language.

(b) OIRA Responsibilities. The Administrator of OIRA shall provide meaningful guidance and oversight so that each agency's

regulatory actions are consistent with applicable law, the President's priorities, and the principles set forth in this Executive order and do not conflict with the policies or actions of another agency. OIRA shall, to the extent permitted by law, adhere to the following guidelines:

(1) OIRA may review only actions identified by the agency or by OIRA as significant regulatory actions under subsection (a)(3)(A) of this section.

(2) OIRA shall waive review or notify the agency or by OIRA as significant regulatory actions under subsection (a)(3)(A) of this section.

(A) For any notices of inquiry, advance notices of proposed rulemaking, or other preliminary regulatory actions prior to a notice of proposed rulemaking, within 10 working days after the date of submission of the draft action to OIRA;

(B) For all other regulatory actions, within 90 calendar days after the date of submission of the information set forth in subsections (a)(3)(B) and (C) of this section, unless OIRA has previously reviewed this information and, since that review, there has been no material change in the facts and circumstances upon which the regulatory action is based, in which case, OIRA shall complete its review within 45 days; and

(C) The review process may be extended (1) once by no more than 30 calendar days upon the written approval of the Director and (2) at the request of the agency head.

(3) For each regulatory action that the Administrator of OIRA returns to an agency for further consideration of some of all of its provisions, the Administrator of OIRA shall provide the issuing agency a written explanation for such return, setting forth the pertinent provision of this Executive order on which OIRA is relying. If the agency head disagrees with some or all of the bases for the return, the agency head shall so inform the Administrator of OIRA in writing.

(4) Except as otherwise provided by law or required by a Court, in order to ensure greater openness, accessibility, and accountability in the regulatory review process, OIRA shall be governed by the following disclosure requirements:

(A) Only the Administrator of OIRA (or a particular designee) shall receive oral communications initiated by persons not employed by the executive branch of the Federal Government regarding the substance of a regulatory action under OIRA review;

(B) All substantive communications between OIRA personnel and persons not employed by the executive branch of the Federal Government regarding a regulatory action under review shall be governed by the following guidelines: (i) A representative from the issuing agency shall be invited to any meeting between OIRA personnel and such person(s);

(ii) OIRA shall forward to the issuing agency, within 10 working days of receipt of the communication(s), all written communications, regardless of format, between OIRA personnel and any person who is not employed by the executive branch of the Federal Government, and the dates and names of individuals involved in all substantive oral communications (including meetings to which an agency representative was invited, but did not attend, and telephone conversations between OIRA personnel and any such persons); and

(iii) OIRA shall publicly disclose relevant information about such communication(s), as set forth below in subsection (b)(4)(C) of this section.

(C) OIRA shall maintain a publicly available log that shall contain, at a minimum, the following information pertinent to regulatory actions under review:

(i) The status of all regulatory actions, including if (and if so, when and by whom) Vice Presidential and Presidential consideration was requested;

(ii) A notation of all written communications forwarded to an issuing agency under subsection (b)(4)(B)(ii) of this section; and

(iii) The dates and names of individuals involved in all substantive oral communications, including meetings and telephone conversations, between OIRA personnel and any person not employed by the executive branch of the Federal Government, and the subject matter discussed during such communications.

(D) After the regulatory action has been published in the Federal Register or otherwise issued to the public, or after the agency has announced its decision not to publish or issue the regulatory action, OIRA shall make available to the public all documents exchanged between OIRA and the agency during the review by OIRA under this section.

(5) All information provided to the public by OIRA shall be in plain, understandable language.

Sec. 7. Resolution of Conflicts. To the extent permitted by law, disagreements or conflicts between or among agency heads or between OMB and any agency that cannot be resolved by the Administrator of OIRA shall be resolved by the President, or by the Vice President acting at the request of the President, with the relevant agency head (and, as appropriate, other interested government officials). Vice Presidential and Presidential consideration of such disagreements may be initiated only by the Director, by the head of the issuing agency, or by the head of an agency that has a significant interest in the regulatory action at issue. Such review will not be undertaken at the request of other persons, entities, or their agents.

Resolution of such conflicts shall be informed by recommendations developed by the Vice President, after consultation with the Advisors (and other executive branch officials or personnel whose responsibilities to the President include the subject matter at issue). The development of these recommendations shall be concluded within 60 days after review has been requested.

During the Vice Presidential and Presidential review period, communications with any person not employed by the Federal Government relating to the substance of the regulatory action under review and directed to the Advisors or their staffs or to the staff of the Vice President shall be in writing and shall be forwarded by the recipient to the affected agency(ies) for inclusion in the public docket(s). When the communication is not in writing, such Advisors or staff members shall inform the outside party that the matter is under review and that any comments should be submitted in writing.

At the end of this review process, the President, or the Vice President acting at the request of the President, shall notify the affected agency and the Administrator of OIRA of the President's decision with the respect to the matter.

Sec. 8. Publication. Except to the extent required by law, an agency shall not publish in the Federal Register or otherwise issue to the public any regulatory action that ia subject to review under section 6 of this Executive order until (1) the Administrator of OIRA notifies the agency that OIRA has waived its review of the action or has completed its review without any requests for further consideration, or (2) the applicable time period in section 6(b)(2) expires without OIRA having notified the agency that it is returning the regulatory action for further consideration under section 6(b)(3), whichever occurs first. If the terms of the preceding sentence have not been satisfied and an agency wants to publish or otherwise issue a regulatory action, the head of that agency may request Presidential consideration through the Vice President, as provided under section 7 of this order. Upon receipt of this request, the Vice President shall notify OIRA and the Advisors. The guidelines and time period set forth in section 7 shall apply to the publication of regulatory actions for which Presidential consideration has been sought.

Sec. 9. Agency Authority. Nothing in this order shall be construed as displacing the agencies' authority or responsibilities, as authorized by law.

Sec. 10. Judicial Review. Nothing in this Executive order shall affect any otherwise available judicial review of agency action. This Executive order is intended only to improve the internal management of the Federal Government and does not create any right or benefit, substantive or procedural, enforceable at law or equity by a party against the United States, its agencies or instrumentalities, its officers or employees, or any other person.

Sec. 11. Revocations. Executive Orders Nos. 12291 and 12498; all amendments to those Executive orders; all guidelines issued under those orders; and any exemptions from those orders heretofore granted for any category of rule are revoked.

/s/William J. Clinton

THE WHITE HOUSE,
September 30, 1993.

Appendix C: OMB Circular A-4, *Regulatory Analysis,* issued September 17, 2003

Office of Management and Budget

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Circular A-4

September 17, 2003

TO THE HEADS OF EXECUTIVE AGENCIES AND ESTABLISHMENTS

Subject: Regulatory Analysis

This Circular provides the Office of Management and Budget's (OMB's) guidance to Federal agencies on the development of regulatory analysis as required under Section 6(a)(3)(c) of Executive Order12866, "Regulatory Planning and Review," the Regulatory Right-to-Know Act, and a variety of related authorities. The Circular also provides guidance to agencies on the regulatory accounting statements that are required under the Regulatory Right-to-Know Act. This Circular refines OMB's "best practices" document of 1996 (http://www.whitehouse.gov/omb/inforeg/riaguide.html), which was issued as a guidance in 2000 (http://www.whitehouse.gov/omb/memoranda/m00-08.pdf), and reaffirmed in 2001 (http://www.whitehouse.gov/omb/memoranda/m01-23.html). It replaces both the 1996 "best practices" and the 2000 guidance.
In developing this Circular, OMB first developed a draft that was subject to public comment, interagency review, and peer review. Peer reviewers included Cass Sunstein, University of Chicago; Lester Lave, Carnegie Mellon University; Milton C. Weinstein and James K. Hammitt of the Harvard School of Public Health; Kerry Smith, North Carolina State University; Jonathan Weiner, Duke University Law School; Douglas K. Owens, Stanford University; and W. Kip Viscusi, Harvard Law School. Although these individuals submitted comments, OMB is solely responsible for the final content of this Circular.

A. Introduction

This Circular is designed to assist analysts in the regulatory agencies by defining good regulatory analysis B called either "regulatory analysis" or "analysis" for brevity B and standardizing the way benefits and costs of Federal regulatory actions are measured and reported. Executive Order 12866 requires agencies to conduct a regulatory analysis for economically significant regulatory actions as defined by

Section 3(f)(1). This requirement applies to rulemakings that rescind or modify existing rules as well as to rulemakings that establish new requirements.

The Need for Analysis of Proposed Regulatory Actions[1]

Regulatory analysis is a tool regulatory agencies use to anticipate and evaluate the likely consequences of rules. It provides a formal way of organizing the evidence on the key effects B good and bad B of the various alternatives that should be considered in developing regulations. The motivation is to (1) learn if the benefits of an action are likely to justify the costs or (2) discover which of various possible alternatives would be the most cost-effective.

A good regulatory analysis is designed to inform the public and other parts of the Government (as well as the agency conducting the analysis) of the effects of alternative actions. Regulatory analysis sometimes will show that a proposed action is misguided, but it can also demonstrate that well-conceived actions are reasonable and justified.

Benefit-cost analysis is a primary tool used for regulatory analysis.[2] Where all benefits and costs can be quantified and expressed in monetary units, benefit-cost analysis provides decision makers with a clear indication of the most efficient alternative, that is, the alternative that generates the largest net benefits to society (ignoring distributional effects). This is useful information for decision makers and the public to receive, even when economic efficiency is not the only or the overriding public policy objective.

It will not always be possible to express in monetary units all of the important benefits and costs. When it is not, the most efficient alternative will not necessarily be the one with the largest quantified and monetized net-benefit estimate. In such cases, you should exercise professional judgment in determining how important the non-quantified benefits or costs may be in the context of the overall analysis. If the non-quantified benefits and costs are likely to be important, you should carry out a "threshold" analysis to evaluate their significance. Threshold or "break-even" analysis answers the question, "How small could the value of the non-quantified benefits be (or how large would the value of the non-quantified costs need to be) before the rule would yield zero net benefits?" In addition to threshold analysis you should indicate, where possible, which non-quantified effects are most important and why.

Key Elements of a Regulatory Analysis

A good regulatory analysis should include the following three basic elements: (1) a statement of the need for the proposed action, (2) an examination of alternative approaches, and (3) an evaluation of the benefits and costs—quantitative and qualitative—of the proposed action and the main alternatives identified by the analysis.

To evaluate properly the benefits and costs of regulations and their alternatives, you will need to do the following:

- Explain how the actions required by the rule are linked to the expected benefits. For example, indicate how additional safety equipment will reduce safety risks. A similar analysis should be done for each of the alternatives.
- Identify a baseline. Benefits and costs are defined in comparison with a clearly stated alternative. This normally will be a "no action" baseline: what the world will be like if the proposed rule is not adopted. Comparisons to a "next best" alternative are also especially useful.
- Identify the expected undesirable side-effects and ancillary benefits of the proposed regulatory action and the alternatives. These should be added to the direct benefits and costs as appropriate.

With this information, you should be able to assess quantitatively the benefits and costs of the proposed rule and its alternatives. A complete regulatory analysis includes a discussion of non-quantified as well as quantified benefits and costs. A non-quantified outcome is a benefit or cost that has not been quantified or monetized in the analysis. When there are important non-monetary values at stake, you should also identify them in your analysis so policymakers can compare them with the monetary benefits and costs. When your analysis is complete, you should present a summary of the benefit and cost estimates for each alternative, including the qualitative and non-monetized factors affected by the rule, so that readers can evaluate them.

As you design, execute, and write your regulatory analysis, you should seek out the opinions of those who will be affected by the regulation as well as the views of those individuals and organizations who may not be affected but have special knowledge or insight into the regulatory issues. Consultation can be useful in ensuring that your analysis addresses all of the relevant issues and that you have access to all pertinent data. Early consultation can be especially helpful. You should not limit consultation to the final stages of your analytical efforts.

You will find that you cannot conduct a good regulatory analysis according to a formula. Conducting high-quality analysis requires competent professional judgment. Different regulations may call for different emphases in the analysis, depending on the nature and complexity of the regulatory issues and the sensitivity of the benefit and cost estimates to the key assumptions.

A good analysis is transparent. It should be possible for a qualified third party reading the report to see clearly how you arrived at your estimates and conclusions. For transparency's sake, you should state in your report what assumptions were used, such as the time horizon for the analysis and the discount rates applied to future benefits and costs. It is usually necessary to provide a sensitivity analysis to reveal whether, and to what extent, the results of the analysis are sensitive to plausible changes in the main assumptions and numeric inputs.

A good analysis provides specific references to all sources of data,

appendices with documentation of models (where necessary), and the results of formal sensitivity and other uncertainty analyses. Your analysis should also have an executive summary, including a standardized accounting statement.

B. The Need for Federal Regulatory Action

Before recommending Federal regulatory action, an agency must demonstrate that the proposed action is necessary. If the regulatory intervention results from a statutory or judicial directive, you should describe the specific authority for your action, the extent of discretion available to you, and the regulatory instruments you might use. Executive Order 12866 states that "Federal agencies should promulgate only such regulations as are required by law, are necessary to interpret the law, or are made necessary by compelling need, such as material failures of private markets to protect or improve the health and safety of the public, the environment, or the well being of the American people ... ."
Executive Order 12866 also states that "Each agency shall identify the problem that it intends to address (including, where applicable, the failures of private markets or public institutions that warrant new agency action) as well as assess the significance of that problem." Thus, you should try to explain whether the action is intended to address a significant market failure or to meet some other compelling public need such as improving governmental processes or promoting intangible values such as distributional fairness or privacy. If the regulation is designed to correct a significant market failure, you should describe the failure both qualitatively and (where feasible) quantitatively. You should show that a government intervention is likely to do more good than harm. For other interventions, you should also provide a demonstration of compelling social purpose and the likelihood of effective action. Although intangible rationales do not need to be quantified, the analysis should present and evaluate the strengths and limitations of the relevant arguments for these intangible values.

Market Failure or Other Social Purpose

The major types of market failure include: externality, market power, and inadequate or asymmetric information. Correcting market failures is a reason for regulation, but it is not the only reason. Other possible justifications include improving the functioning of government, removing distributional unfairness, or promoting privacy and personal freedom.

1. Externality, common property resource and public good

An externality occurs when one party's actions impose uncompensated benefits or costs on another party. Environmental problems are a classic case of externality. For example, the smoke from a factory may

adversely affect the health of local residents while soiling the property in nearby neighborhoods. If bargaining were costless and all property rights were well defined, people would eliminate externalities through bargaining without the need for government regulation.[3] From this perspective, externalities arise from high transactions costs and/or poorly defined property rights that prevent people from reaching efficient outcomes through market transactions.
Resources that may become congested or overused, such as fisheries or the broadcast spectrum, represent common property resources. "Public goods," such as defense or basic scientific research, are goods where provision of the good to some individuals cannot occur without providing the same level of benefits free of charge to other individuals.

2. Market Power

Firms exercise market power when they reduce output below what would be offered in a competitive industry in order to obtain higher prices. They may exercise market power collectively or unilaterally. Government action can be a source of market power, such as when regulatory actions exclude low-cost imports. Generally, regulations that increase market power for selected entities should be avoided. However, there are some circumstances in which government may choose to validate a monopoly. If a market can be served at lowest cost only when production is limited to a single producer B local gas and electricity distribution services, for example B a natural monopoly is said to exist. In such cases, the government may choose to approve the monopoly and to regulate its prices and/or production decisions. Nevertheless, you should keep in mind that technological advances often affect economies of scale. This can, in turn, transform what was once considered a natural monopoly into a market where competition can flourish.

3. Inadequate or Asymmetric Information

Market failures may also result from inadequate or asymmetric information. Because information, like other goods, is costly to produce and disseminate, your evaluation will need to do more than demonstrate the possible existence of incomplete or asymmetric information. Even though the market may supply less than the full amount of information, the amount it does supply may be reasonably adequate and therefore not require government regulation. Sellers have an incentive to provide information through advertising that can increase sales by highlighting distinctive characteristics of their products. Buyers may also obtain reasonably adequate information about product characteristics through other channels, such as a seller offering a warranty or a third party providing information.
Even when adequate information is available, people can make mistakes by processing it poorly. Poor information-processing often occurs in cases of low probability, high-consequence events, but it is not limited to such situations. For instance, people sometimes rely on mental rules-of-thumb that produce errors. If they have a clear mental

image of an incident which makes it cognitively "available," they might overstate the probability that it will occur. Individuals sometimes process information in a biased manner, by being too optimistic or pessimistic, without taking sufficient account of the fact that the outcome is exceedingly unlikely to occur. When mistakes in information processing occur, markets may overreact. When it is time-consuming or costly for consumers to evaluate complex information about products or services (e.g., medical therapies), they may expect government to ensure that minimum quality standards are met. However, the mere possibility of poor information processing is not enough to justify regulation. If you think there is a problem of information processing that needs to be addressed, it should be carefully documented.

4. Other Social Purposes

There are justifications for regulations in addition to correcting market failures. A regulation may be appropriate when you have a clearly identified measure that can make government operate more efficiently. In addition, Congress establishes some regulatory programs to redistribute resources to select groups. Such regulations should be examined to ensure that they are both effective and cost-effective. Congress also authorizes some regulations to prohibit discrimination that conflicts with generally accepted norms within our society. Rulemaking may also be appropriate to protect privacy, permit more personal freedom or promote other democratic aspirations.

Showing That Regulation at the Federal Level Is the Best Way to Solve the Problem

Even where a market failure clearly exists, you should consider other means of dealing with the failure before turning to Federal regulation. Alternatives to Federal regulation include antitrust enforcement, consumer-initiated litigation in the product liability system, or administrative compensation systems.

In assessing whether Federal regulation is the best solution, you should also consider the possibility of regulation at the State or local level. In some cases, the nature of the market failure may itself suggest the most appropriate governmental level of regulation. For example, problems that spill across State lines (such as acid rain whose precursors are transported widely in the atmosphere) are probably best addressed by Federal regulation. More localized problems, including those that are common to many areas, may be more efficiently addressed locally.

The advantages of leaving regulatory issues to State and local authorities can be substantial. If public values and preferences differ by region, those differences can be reflected in varying State and local regulatory policies. Moreover, States and localities can serve as a testing ground for experimentation with alternative regulatory policies. One State can learn from another's experience while local jurisdictions

may compete with each other to establish the best regulatory policies. You should examine the proper extent of State and local discretion in your rulemaking context.

A diversity of rules may generate gains for the public as governmental units compete with each other to serve the public, but duplicative regulations can also be costly. Where Federal regulation is clearly appropriate to address interstate commerce issues, you should try to examine whether it would be more efficient to retain or reduce State and local regulation. The local benefits of State regulation may not justify the national costs of a fragmented regulatory system. For example, the increased compliance costs for firms to meet different State and local regulations may exceed any advantages associated with the diversity of State and local regulation. Your analysis should consider the possibility of reducing as well as expanding State and local rulemaking.

The role of Federal regulation in facilitating U.S. participation in global markets should also be considered. Harmonization of U.S. and international rules may require a strong Federal regulatory role. Concerns that new U.S. rules could act as non-tariff barriers to imported goods should be evaluated carefully.

The Presumption Against Economic Regulation

Government actions can be unintentionally harmful, and even useful regulations can impede market efficiency. For this reason, there is a presumption against certain types of regulatory action. In light of both economic theory and actual experience, a particularly demanding burden of proof is required to demonstrate the need for any of the following types of regulations:

- price controls in competitive markets;
- production or sales quotas in competitive markets;
- mandatory uniform quality standards for goods or services if the potential problem can be adequately dealt with through voluntary standards or by disclosing information of the hazard to buyers or users; or
- controls on entry into employment or production, except (a) where indispensable to protect health and safety (e.g., FAA tests for commercial pilots) or (b) to manage the use of common property resources (e.g., fisheries, airwaves, Federal lands, and offshore areas).

C. Alternative Regulatory Approaches

Once you have determined that Federal regulatory action is appropriate, you will need to consider alternative regulatory approaches. Ordinarily, you will be able to eliminate some alternatives through a preliminary analysis, leaving a manageable number of alternatives to be evaluated according to the formal principles of the Executive Order. The number and choice of alternatives selected for

detailed analysis is a matter of judgment. There must be some balance between thoroughness and the practical limits on your analytical capacity. With this qualification in mind, you should nevertheless explore modifications of some or all of a regulation's attributes or provisions to identify appropriate alternatives. The following is a list of alternative regulatory actions that you should consider.

Different Choices Defined by Statute

When a statute establishes a specific regulatory requirement and the agency is considering a more stringent standard, you should examine the benefits and costs of reasonable alternatives that reflect the range of the agency's statutory discretion, including the specific statutory requirement.

Different Compliance Dates

The timing of a regulation may also have an important effect on its net benefits. Benefits may vary significantly with different compliance dates where a delay in implementation may result in a substantial loss in future benefits (e.g., a delay in implementation could result in a significant reduction in spawning stock and jeopardize a fishery). Similarly, the cost of a regulation may vary substantially with different compliance dates for an industry that requires a year or more to plan its production runs. In this instance, a regulation that provides sufficient lead time is likely to achieve its goals at a much lower overall cost than a regulation that is effective immediately.

Different Enforcement Methods

Compliance alternatives for Federal, State, or local enforcement include on-site inspections, periodic reporting, and noncompliance penalties structured to provide the most appropriate incentives. When alternative monitoring and reporting methods vary in their benefits and costs, you should identify the most appropriate enforcement framework. For example, in some circumstances random monitoring or parametric monitoring will be less expensive and nearly as effective as continuous monitoring.

Different Degrees of Stringency

In general, both the benefits and costs associated with a regulation will increase with the level of stringency (although marginal costs generally increase with stringency, whereas marginal benefits may decrease). You should study alternative levels of stringency to understand more fully the relationship between stringency and the size and distribution of benefits and costs among different groups.

Different Requirements for Different Sized Firms

You should consider setting different requirements for large and small firms, basing the requirements on estimated differences in the expected costs of compliance or in the expected benefits. The balance of benefits and costs can shift depending on the size of the firms being regulated. Small firms may find it more costly to comply with regulation, especially if there are large fixed costs required for regulatory compliance. On the other hand, it is not efficient to place a heavier burden on one segment of a regulated industry solely because it can better afford the higher cost. This has the potential to load costs on the most productive firms, costs that are disproportionate to the damages they create. You should also remember that a rule with a significant impact on a substantial number of small entities will trigger the requirements set forth in the Regulatory Flexibility Act. (5 U.S.C. 603(c), 604).

Different Requirements for Different Geographic Regions

Rarely do all regions of the country benefit uniformly from government regulation. It is also unlikely that costs will be uniformly distributed across the country. Where there are significant regional variations in benefits and/or costs, you should consider the possibility of setting different requirements for the different regions.

Performance Standards Rather than Design Standards

Performance standards express requirements in terms of outcomes rather than specifying the means to those ends. They are generally superior to engineering or design standards because performance standards give the regulated parties the flexibility to achieve regulatory objectives in the most cost-effective way. In general, you should take into account both the cost savings to the regulated parties of the greater flexibility and the costs of assuring compliance through monitoring or some other means.

Market-Oriented Approaches Rather than Direct Controls

Market-oriented approaches that use economic incentives should be explored. These alternatives include fees, penalties, subsidies, marketable permits or offsets, changes in liability or property rights (including policies that alter the incentives of insurers and insured parties), and required bonds, insurance or warranties. One example of a market-oriented approach is a program that allows for averaging, banking, and/or trading (ABT) of credits for achieving additional emission reductions beyond the required air emission standards. ABT programs can be extremely valuable in reducing costs or achieving earlier or greater benefits, particularly when the costs of achieving compliance vary across production lines, facilities, or firms. ABT can be

allowed on a plant-wide, firm-wide, or region-wide basis rather than vent by vent, provided this does not produce unacceptable local air quality outcomes (such as "hot spots" from local pollution concentration).

Informational Measures Rather than Regulation

If intervention is contemplated to address a market failure that arises from inadequate or asymmetric information, informational remedies will often be preferred. Measures to improve the availability of information include government establishment of a standardized testing and rating system (the use of which could be mandatory or voluntary), mandatory disclosure requirements (e.g., by advertising, labeling, or enclosures), and government provision of information (e.g., by government publications, telephone hotlines, or public interest broadcast announcements). A regulatory measure to improve the availability of information, particularly about the concealed characteristics of products, provides consumers a greater choice than a mandatory product standard or ban.

Specific informational measures should be evaluated in terms of their benefits and costs. Some effects of informational measures are easily overlooked. The costs of a mandatory disclosure requirement for a consumer product will include not only the cost of gathering and communicating the required information, but also the loss of net benefits of any information displaced by the mandated information. The other costs also may include the effect of providing information that is ignored or misinterpreted, and inefficiencies arising from the incentive that mandatory disclosure may give to overinvest in a particular characteristic of a product or service.

Where information on the benefits and costs of alternative informational measures is insufficient to provide a clear choice between them, you should consider the least intrusive informational alternative sufficient to accomplish the regulatory objective. To correct an informational market failure it may be sufficient for government to establish a standardized testing and rating system without mandating its use, because competing firms that score well according to the system should thereby have an incentive to publicize the fact.

D. Analytical Approaches

Both benefit-cost analysis (BCA) and cost-effectiveness analysis (CEA) provide a systematic framework for identifying and evaluating the likely outcomes of alternative regulatory choices. A major rulemaking should be supported by both types of analysis wherever possible. Specifically, you should prepare a CEA for all major rulemakings for which the primary benefits are improved public health and safety to the extent that a valid effectiveness measure can be developed to represent expected health and safety outcomes. You should also perform a BCA for major health and safety rulemakings to the extent that valid monetary values can be assigned to the primary expected health and safety outcomes. In undertaking these analyses, it is

important to keep in mind the larger objective of analytical consistency in estimating benefits and costs across regulations and agencies, subject to statutory limitations. Failure to maintain such consistency may prevent achievement of the most risk reduction for a given level of resource expenditure. For all other major rulemakings, you should carry out a BCA. If some of the primary benefit categories cannot be expressed in monetary units, you should also conduct a CEA. In unusual cases where no quantified information on benefits, costs and effectiveness can be produced, the regulatory analysis should present a qualitative discussion of the issues and evidence.

Benefit-Cost Analysis

A distinctive feature of BCA is that both benefits and costs are expressed in monetary units, which allows you to evaluate different regulatory options with a variety of attributes using a common measure.[4] By measuring incremental benefits and costs of successively more stringent regulatory alternatives, you can identify the alternative that maximizes net benefits.

The size of net benefits, the absolute difference between the projected benefits and costs, indicates whether one policy is more efficient than another. The ratio of benefits to costs is not a meaningful indicator of net benefits and should not be used for that purpose. It is well known that considering such ratios alone can yield misleading results.

Even when a benefit or cost cannot be expressed in monetary units, you should still try to measure it in terms of its physical units. If it is not possible to measure the physical units, you should still describe the benefit or cost qualitatively. For more information on describing qualitative information, see the section "*Developing Benefit and Cost Estimates*."

When important benefits and costs cannot be expressed in monetary units, BCA is less useful, and it can even be misleading, because the calculation of net benefits in such cases does not provide a full evaluation of all relevant benefits and costs.

You should exercise professional judgment in identifying the importance of non-quantified factors and assess as best you can how they might change the ranking of alternatives based on estimated net benefits. If the non-quantified benefits and costs are likely to be important, you should recommend which of the non-quantified factors are of sufficient importance to justify consideration in the regulatory decision. This discussion should also include a clear explanation that support designating these non-quantified factors as important. In this case, you should also consider conducting a threshold analysis to help decision makers and other users of the analysis to understand the potential significance of these factors to the overall analysis.

Cost-Effectiveness Analysis[5]

Cost-effectiveness analysis can provide a rigorous way to identify options that achieve the most effective use of the resources available without requiring monetization of all of relevant benefits or costs.

Generally, cost-effectiveness analysis is designed to compare a set of regulatory actions with the same primary outcome (e.g., an increase in the acres of wetlands protected) or multiple outcomes that can be integrated into a single numerical index (e.g., units of health improvement).

Cost-effectiveness results based on averages need to be treated with great care. They suffer from the same drawbacks as benefit-cost ratios. The alternative that exhibits the smallest cost-effectiveness ratio may not be the best option, just as the alternative with the highest benefit-cost ratio is not always the one that maximizes net benefits. Incremental cost-effectiveness analysis (discussed below) can help to avoid mistakes that can occur when policy choices are based on average cost-effectiveness.

CEA can also be misleading when the "effectiveness" measure does not appropriately weight the consequences of the alternatives. For example, when effectiveness is measured in tons of reduced pollutant emissions, cost-effectiveness estimates will be misleading unless the reduced emissions of diverse pollutants result in the same health and environmental benefits.

When you have identified a range of alternatives (e.g., different levels of stringency), you should determine the cost-effectiveness of each option compared with the baseline as well as its incremental cost-effectiveness compared with successively more stringent requirements. Ideally, your CEA would present an array of cost-effectiveness estimates that would allow comparison across different alternatives. However, analyzing all possible combinations is not practical when there are many options (including possible interaction effects). In these cases, you should use your judgment to choose reasonable alternatives for careful consideration.

When constructing and comparing incremental cost-effectiveness ratios, you should be careful to determine whether the various alternatives are mutually exclusive or whether they can be combined. If they can be combined, you should consider which might be favored under different regulatory budget constraints (implicit or explicit). You should also make sure that inferior alternatives identified by the principles of strong and weak dominance are eliminated from consideration.[6]

The value of CEA is enhanced when there is consistency in the analysis across a diverse set of possible regulatory actions. To achieve consistency, you need to carefully construct the two key components of any CEA: the cost and the "effectiveness" or performance measures for the alternative policy options.

With regard to measuring costs, you should be sure to include all the relevant costs to society B whether public or private. Rulemakings may also yield cost savings (e.g., energy savings associated with new technologies). The numerator in the cost-effectiveness ratio should reflect net costs, defined as the gross cost incurred to comply with the requirements (sometimes called "total" costs) minus any cost savings. You should be careful to avoid double-counting effects in both the numerator and the denominator of the cost-effectiveness ratios. For

example, it would be incorrect to reduce gross costs by an estimated monetary value on life extension if life-years are already used as the effectiveness measure in the denominator.

In constructing measures of "effectiveness", final outcomes, such as lives saved or life-years saved, are preferred to measures of intermediate outputs, such as tons of pollution reduced, crashes avoided, or cases of disease avoided. Where the quality of the measured unit varies (e.g., acres of wetlands vary substantially in terms of their ecological benefits), it is important that the measure capture the variability in the value of the selected "outcome" measure. You should provide an explanation of your choice of effectiveness measure.

Where regulation may yield several different beneficial outcomes, a cost-effectiveness comparison becomes more difficult to interpret because there is more than one measure of effectiveness to incorporate in the analysis. To arrive at a single measure you will need to weight the value of disparate benefit categories, but this computation raises some of the same difficulties you will encounter in BCA. If you can assign a reasonable monetary value to all of the regulation's different benefits, then you should do so. But in this case, you will be doing BCA, not CEA.

When you can estimate the monetary value of some but not all of the ancillary benefits of a regulation, but cannot assign a monetary value to the primary measure of effectiveness, you should subtract the monetary estimate of the ancillary benefits from the gross cost estimate to yield an estimated net cost. (This net cost estimate for the rule may turn out to be negative B that is, the monetized benefits exceed the cost of the rule.) If you are unable to estimate the value of some of the ancillary benefits, the cost-effectiveness ratio will be overstated, and this should be acknowledged in your analysis. CEA does not yield an unambiguous choice when there are benefits or costs that have not been incorporated in the net-cost estimates. You also may use CEA to compare regulatory alternatives in cases where the statute specifies the level of benefits to be achieved.

The Effectiveness Metric for Public Health and Safety Rulemakings

When CEA is applied to public health and safety rulemakings, one or more measures of effectiveness must be selected that permits comparison of regulatory alternatives. Agencies currently use a variety of effectiveness measures.

There are relatively simple measures such as the number of lives saved, cases of cancer reduced, and cases of paraplegia prevented. Sometimes these measures account only for mortality information, such as the number of lives saved and the number of years of life saved. There are also more comprehensive, integrated measures of effectiveness such as the number of "equivalent lives" (ELs) saved and the number of "quality-adjusted life years" (QALYs) saved.

The main advantage of the integrated measures of effectiveness is that they account for a rule's impact on morbidity (nonfatal illness,

injury, impairment and quality of life) as well as premature death. The inclusion of morbidity effects is important because (a) some illnesses (e.g., asthma) cause more instances of pain and suffering than they do premature death, (b) some population groups are known to experience elevated rates of morbidity (e.g, the elderly and the poor) and thus have a strong interest in morbidity measurement[7], and (c) some regulatory alternatives may be more effective at preventing morbidity than premature death (e.g., some advanced airbag designs may diminish the nonfatal injuries caused by airbag inflation without changing the frequency of fatal injury prevented by airbags).

However, the main drawback of these integrated measures is that they must meet some restrictive assumptions to represent a valid measure of individual preferences.[8] For example, a QALY measure implicitly assumes that the fraction of remaining lifespan an individual would give up for an improvement in health-related quality of life does not depend on the remaining lifespan. Thus, if an individual is willing to give up 10 years of life among 50 remaining years for a given health improvement, he or she would also be willing to give up 1 year of life among 5 remaining years. To the extent that individual preferences deviate from these assumptions, analytic results from CEA using QALYs could differ from analytic results based on willingness-to-pay-measures. Though willingness to pay is generally the preferred economic method for evaluating preferences, the CEA method, as applied in medicine and health, does not evaluate health changes using individual willingness to pay. When performing CEA, you should consider using at least one integrated measure of effectiveness when a rule creates a significant impact on both mortality and morbidity.

When CEA is performed in specific rulemaking contexts, you should be prepared to make appropriate adjustments to ensure fair treatment of all segments of the population. Fairness is important in the choice and execution of effectiveness measures. For example, if QALYs are used to evaluate a lifesaving rule aimed at a population that happens to experience a high rate of disability (i.e., where the rule is not designed to affect the disability), the number of life years saved should not necessarily be diminished simply because the rule saves the lives of people with life-shortening disabilities. Both analytic simplicity and fairness suggest that the estimated number of life years saved for the disabled population should be based on average life expectancy information for the relevant age cohorts. More generally, when numeric adjustments are made for life expectancy or quality of life, analysts should prefer use of population averages rather than information derived from subgroups dominated by a particular demographic or income group.

OMB does not require agencies to use any specific measure of effectiveness. In fact, OMB encourages agencies to report results with multiple measures of effectiveness that offer different insights and perspectives. The regulatory analysis should explain which measures were selected and why, and how they were implemented.

The analytic discretion provided in choice of effectiveness measure will create some inconsistency in how agencies evaluate the same injuries and diseases, and it will be difficult for OMB and the public to draw

meaningful comparisons between rulemakings that employ different effectiveness measures. As a result, agencies should use their web site to provide OMB and the public with the underlying data, including mortality and morbidity data, the age distribution of the affected populations, and the severity and duration of disease conditions and trauma, so that OMB and the public can construct apples-to-apples comparisons between rulemakings that employ different measures. There are sensitive technical and ethical issues associated with choosing one or more of these integrated measures for use throughout the Federal government. The Institute of Medicine (IOM) may assemble a panel of specialists in cost-effectiveness analysis and bioethics to evaluate the advantages and disadvantages of these different measures and other measures that have been suggested in the academic literature. OMB believes that the IOM guidance will provide Federal agencies and OMB useful insight into how to improve the measurement of effectiveness of public health and safety regulations.

Distributional Effects

Those who bear the costs of a regulation and those who enjoy its benefits often are not the same people. The term "distributional effect" refers to the impact of a regulatory action across the population and economy, divided up in various ways (e.g., income groups, race, sex, industrial sector, geography). Benefits and costs of a regulation may also be distributed unevenly over time, perhaps spanning several generations. Distributional effects may arise through "transfer payments" that stem from a regulatory action as well. For example, the revenue collected through a fee, surcharge in excess of the cost of services provided, or tax is a transfer payment.

Your regulatory analysis should provide a separate description of distributional effects (i.e., how both benefits and costs are distributed among sub-populations of particular concern) so that decision makers can properly consider them along with the effects on economic efficiency. Executive Order 12866 authorizes this approach. Where distributive effects are thought to be important, the effects of various regulatory alternatives should be described quantitatively to the extent possible, including the magnitude, likelihood, and severity of impacts on particular groups. You should be alert for situations in which regulatory alternatives result in significant changes in treatment or outcomes for different groups. Effects on the distribution of income that are transmitted through changes in market prices can be important, albeit sometimes difficult to assess. Your analysis should also present information on the streams of benefits and costs over time in order to provide a basis for assessing intertemporal distributional consequences, particularly where intergenerational effects are concerned.

E. Identifying and Measuring Benefits and Costs

This Section provides guidelines for your preparation of the benefit

and cost estimates required by Executive Order 12866 and the "Regulatory Right-to-Know Act." The discussions in previous sections will help you identify a workable number of alternatives for consideration in your analysis and an appropriate analytical approach to use.

General Issues

1. Scope of Analysis

Your analysis should focus on benefits and costs that accrue to citizens and residents of the United States. Where you choose to evaluate a regulation that is likely to have effects beyond the borders of the United States, these effects should be reported separately. The time frame for your analysis should cover a period long enough to encompass all the important benefits and costs likely to result from the rule.

2. Developing a Baseline

You need to measure the benefits and costs of a rule against a baseline. This baseline should be the best assessment of the way the world would look absent the proposed action. The choice of an appropriate baseline may require consideration of a wide range of potential factors, including:

- evolution of the market,
- changes in external factors affecting expected benefits and costs,
- changes in regulations promulgated by the agency or other government entities, and
- the degree of compliance by regulated entities with other regulations.

It may be reasonable to forecast that the world absent the regulation will resemble the present. If this is the case, however, your baseline should reflect the future effect of current government programs and policies. For review of an existing regulation, a baseline assuming "no change" in the regulatory program generally provides an appropriate basis for evaluating regulatory alternatives. When more than one baseline is reasonable and the choice of baseline will significantly affect estimated benefits and costs, you should consider measuring benefits and costs against alternative baselines. In doing so you can analyze the effects on benefits and costs of making different assumptions about other agencies' regulations, or the degree of compliance with your own existing rules. In all cases, you must evaluate benefits and costs against the same baseline. You should also discuss the reasonableness of the baselines used in the sensitivity analyses. For each baseline you use, you should identify the key uncertainties in your forecast.

EPA's 1998 final PCB disposal rule provides a good example of using different baselines. EPA used several alternative baselines, each reflecting a different interpretation of existing regulatory requirements. In particular, one baseline reflected a literal interpretation of EPA's 1979 rule and another the actual implementation of that rule in the year immediately preceding the 1998 revision. The use of multiple baselines illustrated the substantial effect changes in EPA's implementation policy could have on the cost of a regulatory program. In the years after EPA adopted the 1979 PCB disposal rule, changes in EPA policy -- especially allowing the disposal of automobile "shredder fluff" in municipal landfills -- reduced the cost of the program by more than $500 million per year.

In some cases, substantial portions of a rule may simply restate statutory requirements that would be self-implementing, even in the absence of the regulatory action. In these cases, you should use a pre-statute baseline. If you are able to separate out those areas where the agency has discretion, you may also use a post-statute baseline to evaluate the discretionary elements of the action.

3. Evaluation of Alternatives

You should describe the alternatives available to you and the reasons for choosing one alternative over another. As noted previously, alternatives that rely on incentives and offer increased flexibility are often more cost-effective than more prescriptive approaches. For instance, user fees and information dissemination may be good alternatives to direct command-and-control regulation. Within a command-and-control regulatory program, performance-based standards generally offer advantages over standards specifying design, behavior, or manner of compliance.

You should carefully consider all appropriate alternatives for the key attributes or provisions of the rule. The previous discussion outlines examples of appropriate alternatives. Where there is a "continuum" of alternatives for a standard (such as the level of stringency), you generally should analyze at least three options: the preferred option; a more stringent option that achieves additional benefits (and presumably costs more) beyond those realized by the preferred option; and a less stringent option that costs less (and presumably generates fewer benefits) than the preferred option.

You should choose reasonable alternatives deserving careful consideration. In some cases, a regulatory program will focus on an option that is near or at the limit of technical feasibility. In this case, the analysis would not need to examine a more stringent option. For each of the options analyzed, you should compare the anticipated benefits to the corresponding costs.

It is not adequate simply to report a comparison of the agency's preferred option to the chosen baseline. Whenever you report the benefits and costs of alternative options, you should present both total and incremental benefits and costs. You should present incremental benefits and costs as differences from the corresponding estimates associated with the next less-stringent alternative.[10] It is important to

emphasize that incremental effects are simply differences between successively more stringent alternatives. Results involving a comparison to a "next best" alternative may be especially useful.
In some cases, you may decide to analyze a wide array of options. In 1998, DOE analyzed a large number of options in setting new energy efficiency standards for refrigerators and freezers and produced a rich amount of information on their relative effects. This analysis -- examining more than 20 alternative performance standards for one class of refrigerators with top-mounted freezers -- enabled DOE to select an option that produced $200 more in estimated net benefits per refrigerator than the least attractive option.
You should analyze the benefits and costs of different regulatory provisions separately when a rule includes a number of distinct provisions. If the existence of one provision affects the benefits or costs arising from another provision, the analysis becomes more complicated, but the need to examine provisions separately remains. In this case, you should evaluate each specific provision by determining the net benefits of the proposed regulation with and without it.
Analyzing all possible combinations of provisions is impractical if the number is large and interaction effects are widespread. You need to use judgment to select the most significant or relevant provisions for such analysis. You are expected to document all of the alternatives that were considered in a list or table and which were selected for emphasis in the main analysis.
You should also discuss the statutory requirements that affect the selection of regulatory approaches. If legal constraints prevent the selection of a regulatory action that best satisfies the philosophy and principles of Executive Order 12866, you should identify these constraints and estimate their opportunity cost. Such information may be useful to Congress under the Regulatory Right-to-Know Act.

4. Transparency and Reproducibility of Results

Because of its influential nature and its special role in the rulemaking process, it is appropriate to set minimum quality standards for regulatory analysis. You should provide documentation that the analysis is based on the best reasonably obtainable scientific, technical, and economic information available. To achieve this, you should rely on peer-reviewed literature, where available, and provide the source for all original information.
A good analysis should be transparent and your results must be reproducible. You should clearly set out the basic assumptions, methods, and data underlying the analysis and discuss the uncertainties associated with the estimates. A qualified third party reading the analysis should be able to understand the basic elements of your analysis and the way in which you developed your estimates. To provide greater access to your analysis, you should generally post it, with all the supporting documents, on the internet so the public can review the findings. You should also disclose the use of outside consultants, their qualifications, and history of contracts and

employment with the agency (e.g., in a preface to the RIA). Where other compelling interests (such as privacy, intellectual property, trade secrets, etc.) prevent the public release of data or key elements of the analysis, you should apply especially rigorous robustness checks to analytic results and document the analytical checks used.
Finally, you should assure compliance with the Information Quality Guidelines for your agency and OMB's "Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by Federal Agencies" ("data quality guidelines")
http://www.whitehouse.gov/omb/fedreg/reproducible.html.

Developing Benefit and Cost Estimates

1. Some General Considerations

The analysis document should discuss the expected benefits and costs of the selected regulatory option and any reasonable alternatives. How is the proposed action expected to provide the anticipated benefits and costs? What are the monetized values of the potential real incremental benefits and costs to society? To present your results, you should:

- include separate schedules of the monetized benefits and costs that show the type and timing of benefits and costs, and express the estimates in this table in constant, undiscounted dollars (for more on discounting see "Discount Rates" below);
- list the benefits and costs you can quantify, but cannot monetize, including their timing;
- describe benefits and costs you cannot quantify; and
- identify or cross-reference the data or studies on which you base the benefit and cost estimates.

When benefit and cost estimates are uncertain (for more on this see "*Treatment of Uncertainty*" below), you should report benefit and cost estimates (including benefits of risk reductions) that reflect the full probability distribution of potential consequences. Where possible, present probability distributions of benefits and costs and include the upper and lower bound estimates as complements to central tendency and other estimates.
If fundamental scientific disagreement or lack of knowledge prevents construction of a scientifically defensible probability distribution, you should describe benefits or costs under plausible scenarios and characterize the evidence and assumptions underlying each alternative scenario.

2. The Key Concepts Needed to Estimate Benefits and Costs

"Opportunity cost" is the appropriate concept for valuing both benefits and costs. The principle of "willingness-to-pay" (WTP) captures the notion of opportunity cost by measuring what individuals are willing to

forgo to enjoy a particular benefit. In general, economists tend to view WTP as the most appropriate measure of opportunity cost, but an individual's "willingness-to-accept" (WTA) compensation for not receiving the improvement can also provide a valid measure of opportunity cost.

WTP and WTA are comparable measures under special circumstances. WTP and WTA measures may be comparable in the following situations: if a regulation affects a price change rather than a quantity change; the change being evaluated is small; there are reasonably close substitutes available; and the income effect is small.[11] However, empirical evidence from experimental economics and psychology shows that even when income/wealth effects are "small", the measured differences between WTP and WTA can be large.[12] WTP is generally considered to be more readily measurable. Adoption of WTP as the measure of value implies that individual preferences of the affected population should be a guiding factor in the regulatory analysis.

Market prices provide rich data for estimating benefits and costs based on willingness-to-pay if the goods and services affected by the regulation are traded in well-functioning competitive markets. The opportunity cost of an alternative includes the value of the benefits forgone as a result of choosing that alternative. The opportunity cost of banning a product -- a drug, food additive, or hazardous chemical -- is the forgone net benefit (i.e., lost consumer and producer surplus[13]) of that product, taking into account the mitigating effects of potential substitutes.

The use of any resource has an opportunity cost regardless of whether the resource is already owned or has to be purchased. That opportunity cost is equal to the net benefit the resource would have provided in the absence of the requirement. For example, if regulation of an industrial plant affects the use of additional land or buildings within the existing plant boundary, the cost analysis should include the opportunity cost of using the additional land or facilities.

To the extent possible, you should monetize any such forgone benefits and add them to the other costs of that alternative. You should also try to monetize any cost savings as a result of an alternative and either add it to the benefits or subtract it from the costs of that alternative. However, you should not assume that the "avoided" costs of not doing another regulatory alternative represent the benefits of a regulatory action where there is no direct, necessary relationship between the two. You should also be careful when the costs avoided are attributable to an existing regulation. Even when there is a direct relationship between the two regulatory actions, the use of avoided costs is problematic because the existing regulation may not maximize net benefits and thus may itself be questionable policy. (See the section, "Direct Use of Market Data," for more detail.)

Estimating benefits and costs when market prices are hard to measure or markets do not exist is more difficult. In these cases, you need to develop appropriate proxies that simulate market exchange. Estimates of willingness-to-pay based on revealed preference methods can be quite useful. As one example, analysts sometimes use "hedonic price

equations" based on multiple regression analysis of market behavior to simulate market prices for the commodity of interest. The hedonic technique allows analysts to develop an estimate of the price for specific attributes associated with a product. For instance, a house is a product characterized by a variety of attributes including the number of rooms, total floor area, and type of heating and cooling. If there are enough data on transactions in the housing market, it is possible to develop an estimate of the implicit price for specific attributes, such as the implicit price of an additional bathroom or for central air conditioning. This technique can be extended, as well, to develop an estimate for the implicit price of public goods that are not directly traded in markets. An analyst can develop implicit price estimates for public goods like air quality and access to public parks by assessing the effects of these goods on the housing market. Going through the analytical process of deriving benefit estimates by simulating markets may also suggest alternative regulatory strategies that create such markets.

You need to guard against double-counting, since some attributes are embedded in other broader measures. To illustrate, when a regulation improves the quality of the environment in a community, the value of real estate in the community generally rises to reflect the greater attractiveness of living in a better environment. Simply adding the increase in property values to the estimated value of improved public health would be double counting if the increase in property values reflects the improvement in public health. To avoid this problem you should separate the embedded effects on the value of property arising from improved public health. At the same time, an analysis that fails to incorporate the consequence of land use changes when accounting for costs will not capture the full effects of regulation.

3. Revealed Preference Methods

Revealed preference methods develop estimates of the value of goods and services -- or attributes of those goods and services -- based on actual market decisions by consumers, workers and other market participants. If the market participant is well informed and confronted with a real choice, it may be feasible to determine accurately and precisely the monetary value needed for a rulemaking. There is a large and well-developed literature on revealed preference in the peer-reviewed, applied economics literature.

Although these methods are well grounded in economic theory, they are sometimes difficult to implement given the complexity of market transactions and the paucity of relevant data. When designing or evaluating a revealed preference study, the following principles should be considered:

- the market should be competitive. If the market isn't competitive (e.g., monopoly, oligopoly), then you should consider making adjustments such that the price reflects the true value to society (often called the "shadow price");
- the market should not exhibit a significant information gap or

asymmetric information problem. If the market suffers from information problems, then you should discuss the divergence of the price from the underlying shadow price and consider possible adjustments to reflect the underlying shadow price;

- the market should not exhibit an externality. In this case, you should discuss the divergence of the price from the underlying shadow price and consider possible adjustments to reflect the underlying shadow price;
- the specific market participants being studied should be representative of the target populations to be affected by the rulemaking under consideration;
- a valid research design and framework for analysis should be adopted. Examples include using data and/or model specifications that include the markets for substitute and complementary goods and services and using reasonably unrestricted functional forms. When specifying substitute and complementary goods, the analysis should preferably be based on data about the range of alternatives perceived by market participants. If such data are not available, you should adopt plausible assumptions and describe the limitations of the analysis.
- the statistical and econometric models employed should be appropriate for the application and the resulting estimates should be robust in response to plausible changes in model specification and estimation technique; and
- the results should be consistent with economic theory.

You should also determine whether there are multiple revealed-preference studies of the same good or service and whether anything can be learned by comparing the methods, data and findings from different studies. Professional judgment is required to determine whether a particular study is of sufficient quality to justify use in regulatory analysis. When studies are used in regulatory analysis despite their technical weaknesses (e.g., due to the absence of other evidence), the regulatory analysis should discuss any biases or uncertainties that are likely to arise due to those weaknesses. If a study has major weaknesses, the study should not be used in regulatory analysis.

a. Direct Uses of Market Data

Economists ordinarily consider market prices as the most accurate measure of the marginal value of goods and services to society. In some instances, however, market prices may not reflect the true value of goods and services due to market imperfections or government intervention. If a regulation involves changes to goods or services where the market price is not a good measure of the value to society, you should use an estimate that reflects the shadow price. Suppose a particular air pollutant damages crops. One of the benefits of controlling that pollutant is the value of the crop yield increase as a result of the controls. That value is typically measured by the price of

the crop. However, if the price is held above the market price by a government program that affects supply, a value estimate based on this price may not reflect the true benefits of controlling the pollutant. In this case, you should calculate the value to society of the increase in crop yields by estimating the shadow price, which reflects the value to society of the marginal use of the crop. If the marginal use is for exports, you should use the world price. If the marginal use is to add to very large surplus stockpiles, you should use the value of the last units released from storage minus storage cost. If stockpiles are large and growing, the shadow price may be low or even negative.

Other goods whose market prices may not reflect their true value include those whose production or consumption results in substantial (1) positive or negative external effects or (2) transfer payments. For example, the observed market price of gasoline may not reflect marginal social value due to the inclusion of taxes, other government interventions, and negative externalities (e.g., pollution). This shadow price may also be needed for goods whose market price is substantially affected by existing regulations that do not maximize net benefits.

b. Indirect Uses of Market Data

Many goods or attributes of goods that are affected by regulation--such as preserving environmental or cultural amenities--are not traded directly in markets. The value for these goods or attributes arise both from use and non-use. Estimation of these values is difficult because of the absence of an organized market. However, overlooking or ignoring these values in your regulatory analysis may significantly understate the benefits and/or costs of regulatory action.

"Use values" arise where an individual derives satisfaction from using the resource, either now or in the future. Use values are associated with activities such as swimming, hunting, and hiking where the individual makes use of the natural environment.

"Non-use values" arise where an individual places value on a resource, good or service even though the individual will not use the resource, now or in the future. Non-use value includes bequest and existence values.

General altruism for the health and welfare of others is a closely related concept but may not be strictly considered a "non-use" value.[14] A general concern for the welfare of others should supplement benefits and costs equally; hence, it is not necessary to measure the size of general altruism in regulatory analysis. If there is evidence of selective altruism, it needs to be considered specifically in both benefits and costs.

Some goods and services are indirectly traded in markets, which means that their value is reflected in the prices of related goods and services that are directly traded in markets. Their use values are typically estimated through revealed preference methods. Examples include estimates of the values of environmental amenities derived from travel-cost studies, and hedonic price models that measure differences or changes in the value of real estate. It is important that

you utilize revealed preference models that adhere to economic criteria that are consistent with utility maximizing behavior. Also, you should take particular care in designing protocols for reliably estimating the values of these attributes.

4. Stated Preference Methods

Stated Preference Methods (SPM) have been developed and used in the peer-reviewed literature to estimate both "use" and "non-use" values of goods and services. They have also been widely used in regulatory analyses by Federal agencies, in part, because these methods can be creatively employed to address a wide variety of goods and services that are not easy to study through revealed preference methods.
The distinguishing feature of these methods is that hypothetical questions about use or non-use values are posed to survey respondents in order to obtain willingness-to-pay estimates relevant to benefit or cost estimation. Some examples of SPM include contingent valuation, conjoint analysis and risk-tradeoff analysis. The surveys used to obtain the health-utility values used in CEA are similar to stated-preference surveys but do not entail monetary measurement of value. Nevertheless, the principles governing quality stated-preference research, with some obvious exceptions involving monetization, are also relevant in designing quality health-utility research.

When you are designing or evaluating a stated-preference study, the following principles should be considered:

- the good or service being evaluated should be explained to the respondent in a clear, complete and objective fashion, and the survey instrument should be pre-tested;
- willingness-to-pay questions should be designed to focus the respondent on the reality of budgetary limitations and alerted to the availability of substitute goods and alternative expenditure options;
- the survey instrument should be designed to probe beyond general attitudes (e.g., a "warm glow" effect for a particular use or non-use value) and focus on the magnitude of the respondent's economic valuation;
- the analytic results should be consistent with economic theory using both "internal" (within respondent) and "external" (between respondent) scope tests such as the willingness to pay is larger (smaller) when more (less) of a good is provided;
- the subjects being interviewed should be selected/sampled in a statistically appropriate manner. The sample frame should adequately cover the target population. The sample should be drawn using probability methods in order to generalize the results to the target population;
- response rates should be as high as reasonably possible. Best survey practices should be followed to achieve high response rates. Low response rates increase the potential for bias and

raise concerns about the generalizability of the results. If response rates are not adequate, you should conduct an analysis of non-response bias or further study. Caution should be used in assessing the representativeness of the sample based solely on demographic profiles. Statistical adjustments to reduce non-response bias should be undertaken whenever feasible and appropriate;

- the mode of administration of surveys (in-person, phone, mail, computer, internet or multiple modes) should be appropriate in light of the nature of the questions being posed to respondents and the length and complexity of the instrument;
- documentation should be provided about the target population, the sampling frame used and its coverage of the target population, the design of the sample including any stratification or clustering, the cumulative response rate (including response rate at each stage of selection if applicable); the item non-response rate for critical questions; the exact wording and sequence of questions and other information provided to respondents; and the training of interviewers and techniques they employed (as appropriate);
- the statistical and econometric methods used to analyze the collected data should be transparent, well suited for the analysis, and applied with rigor and care.

Professional judgment is necessary to apply these criteria to one or more studies, and thus there is no mechanical formula that can be used to determine whether a particular study is of sufficient quality to justify use in regulatory analysis. When studies are used despite having weaknesses on one or more of these criteria, those weaknesses should be acknowledged in the regulatory analysis, including any resulting biases or uncertainties that are likely to result. If a study has too many weaknesses with unknown consequences for the quality of the data, the study should not be used.

The challenge in designing quality stated-preference studies is arguably greater for non-use values and unfamiliar use values than for familiar goods or services that are traded (directly or indirectly) in market transactions. The good being valued may have little meaning to respondents, and respondents may be forming their valuations for the first time in response to the questions posed. Since these values are effectively constructed by the respondent during the elicitation, the instrument and mode of administration should be rigorously pre-tested to make sure that responses are not simply an artifact of specific features of instrument design and/or mode of administration. Since SPM generate data from respondents in a hypothetical setting, often on complex and unfamiliar goods, special care is demanded in the design and execution of surveys, analysis of the results, and characterization of the uncertainties. A stated-preference study may be the only way to obtain quantitative information about non-use values, though a number based on a poor quality study is not necessarily superior to no number at all. Non-use values that are not quantified should be presented as an "intangible" benefit or cost.

If both revealed-preference and stated-preference studies that are directly applicable to regulatory analysis are available, you should consider both kinds of evidence and compare the findings. If the results diverge significantly, you should compare the overall size and quality of the two bodies of evidence. Other things equal, you should prefer revealed preference data over stated preference data because revealed preference data are based on actual decisions, where market participants enjoy or suffer the consequences of their decisions. This is not generally the case for respondents in stated preference surveys, where respondents may not have sufficient incentives to offer thoughtful responses that are more consistent with their preferences or may be inclined to bias their responses for one reason or another.

5. Benefit-Transfer Methods

It is often preferable to collect original data on revealed preference or stated preference to support regulatory analysis. Yet conducting an original study may not be feasible due to the time and expense involved. One alternative to conducting an original study is the use of "benefit transfer" methods. (The transfer may involve cost determination as well). The practice of "benefit transfer" began with transferring existing estimates obtained from indirect market and stated preference studies to new contexts (i.e., the context posed by the rulemaking). The principles that guide transferring estimates from indirect market and stated preference studies should apply to direct market studies as well.

Although benefit-transfer can provide a quick, low-cost approach for obtaining desired monetary values, the methods are often associated with uncertainties and potential biases of unknown magnitude. It should therefore be treated as a last-resort option and not used without explicit justification.

In conducting benefit transfer, the first step is to specify the value to be estimated for the rulemaking. You should identify the relevant measure of the policy change at this initial stage. For instance, you can derive the relevant willingness-to-pay measure by specifying an indirect utility function. This identification allows you to "zero in" on key aspects of the benefit transfer.

The next step is to identify appropriate studies to conduct benefit transfer. In selecting transfer studies for either point transfers or function transfers, you should base your choices on the following criteria:

- The selected studies should be based on adequate data, sound and defensible empirical methods and techniques.
- The selected studies should document parameter estimates of the valuation function.
- The study context and policy context should have similar populations (e.g., demographic characteristics). The market size (e.g., target population) between the study site and the policy site should be similar. For example, a study valuing water quality improvement in Rhode Island should not be used

to value policy that will affect water quality throughout the United States.

- The good, and the magnitude of change in that good, should be similar in the study and policy contexts.
- The relevant characteristics of the study and the policy contexts should be similar. For example, the effects examined in the original study should be "reversible" or "irreversible" to a degree that is similar to the regulatory actions under consideration.
- The distribution of property rights should be similar so that the analysis uses the same welfare measure. If the property rights in the study context support the use of WTA measures while the rights in the rulemaking context support the use of WTP measures, benefit transfer is not appropriate.
- The availability of substitutes across study and policy contexts should be similar.

If you can choose between transferring a function or a point estimate, you should transfer the entire demand function (referred to as benefit function transfer) rather than adopting a single point estimate (referred to as benefit point transfer).[15]
Finally, you should not use benefit transfer in estimating benefits if:

- resources are unique or have unique attributes. For example, if a policy change affects snowmobile use in Yellowstone National Park, then a study valuing snowmobile use in the state of Michigan should not be used to value changes in snowmobile use in the Yellowstone National Park.
- If the study examines a resource that is unique or has unique attributes, you should not transfer benefit estimates or benefit functions to value a different resource and vice versa. For example, if a study values visibility improvements at the Grand Canyon, these results should not be used to value visibility improvements in urban areas.
- There are significant problems with applying an "*ex ante*" valuation estimate to an "ex post" policy context. If a policy yields a significant change in the attributes of the good, you should not use the study estimates to value the change using a benefit transfer approach.
- You also should not use a value developed from a study involving, small marginal changes in a policy context involving large changes in the quantity of the good.

Clearly, all of these criteria are difficult to meet. However, you should attempt to satisfy as many as possible when choosing studies from the existing economic literature. Professional judgment is required in determining whether a particular transfer is too speculative to use in regulatory analysis.

6. Ancillary Benefits and Countervailing Risks

Your analysis should look beyond the direct benefits and direct costs of your rulemaking and consider any important ancillary benefits and countervailing risks. An ancillary benefit is a favorable impact of the rule that is typically unrelated or secondary to the statutory purpose of the rulemaking (e.g., reduced refinery emissions due to more stringent fuel economy standards for light trucks) while a countervailing risk is an adverse economic, health, safety, or environmental consequence that occurs due to a rule and is not already accounted for in the direct cost of the rule (e.g., adverse safety impacts from more stringent fuel-economy standards for light trucks).

You should begin by considering and perhaps listing the possible ancillary benefits and countervailing risks. However, highly speculative or minor consequences may not be worth further formal analysis. Analytic priority should be given to those ancillary benefits and countervailing risks that are important enough to potentially change the rank ordering of the main alternatives in the analysis. In some cases the mere consideration of these secondary effects may help in the generation of a superior regulatory alternative with strong ancillary benefits and fewer countervailing risks. For instance, a recent study suggested that weight-based, fuel-economy standards could achieve energy savings with fewer safety risks and employment losses than would occur under the current regulatory structure.

Like other benefits and costs, an effort should be made to quantify and monetize ancillary benefits and countervailing risks. If monetization is not feasible, quantification should be attempted through use of informative physical units. If both monetization and quantification are not feasible, then these issues should be presented as non-quantified benefits and costs. The same standards of information and analysis quality that apply to direct benefits and costs should be applied to ancillary benefits and countervailing risks.

One way to combine ancillary benefits and countervailing risks is to evaluate these effects separately and then put both of these effects on the benefits side, not on the cost side. Although it is theoretically appropriate to include disbenefits on the cost side, legal and programmatic considerations generally support subtracting the disbenefits from direct benefits.

7. Methods for Treating Non-Monetized Benefits and Costs

Sound quantitative estimates of benefits and costs, where feasible, are preferable to qualitative descriptions of benefits and costs because they help decision makers understand the magnitudes of the effects of alternative actions. However, some important benefits and costs (e.g., privacy protection) may be inherently too difficult to quantify or monetize given current data and methods. You should carry out a careful evaluation of non-quantified benefits and costs. Some authorities[16] refer to these non-monetized and non-quantified effects

as "intangible".

a. Benefits and Costs that are Difficult to Monetize

You should monetize quantitative estimates whenever possible. Use sound and defensible values or procedures to monetize benefits and costs, and ensure that key analytical assumptions are defensible. If monetization is impossible, explain why and present all available quantitative information. For example, if you can quantify but cannot monetize increases in water quality and fish populations resulting from water quality regulation, you can describe benefits in terms of stream miles of improved water quality for boaters and increases in game fish populations for anglers. You should describe the timing and likelihood of such effects and avoid double-counting of benefits when estimates of monetized and physical effects are mixed in the same analysis.

b. Benefits and Costs that are Difficult to Quantify

If you are not able to quantify the effects, you should present any relevant quantitative information along with a description of the unquantified effects, such as ecological gains, improvements in quality of life, and aesthetic beauty. You should provide a discussion of the strengths and limitations of the qualitative information. This should include information on the key reason(s) why they cannot be quantified. In one instance, you may know with certainty the magnitude of a risk to which a substantial, but unknown, number of individuals are exposed. In another instance, the existence of a risk may be based on highly speculative assumptions, and the magnitude of the risk may be unknown.

For cases in which the unquantified benefits or costs affect a policy choice, you should provide a clear explanation of the rationale behind the choice. Such an explanation could include detailed information on the nature, timing, likelihood, location, and distribution of the unquantified benefits and costs. Also, please include a summary table that lists all the unquantified benefits and costs, and use your professional judgment to highlight (e.g., with categories or rank ordering) those that you believe are most important (e.g., by considering factors such as the degree of certainty, expected magnitude, and reversibility of effects).

While the focus is often placed on difficult to quantify benefits of regulatory action, some costs are difficult to quantify as well. Certain permitting requirements (e.g., EPA's New Source Review program) restrict the decisions of production facilities to shift to new products and adopt innovative methods of production. While these programs may impose substantial costs on the economy, it is very difficult to quantify and monetize these effects. Similarly, regulations that establish emission standards for recreational vehicles, like motor bikes, may adversely affect the performance of the vehicles in terms of driveability and 0 to 60 miles per hour acceleration. Again, the cost associated with the loss of these attributes may be difficult to quantify and monetize. They need to be analyzed qualitatively.

8. Monetizing Health and Safety Benefits and Costs

We expect you to provide a benefit-cost analysis of major health and safety rulemakings in addition to a CEA. The BCA provides additional insight because (a) it provides some indication of what the public is willing to pay for improvements in health and safety and (b) it offers additional information on preferences for health using a different research design than is used in CEA. Since the health-preference methods used to support CEA and BCA have some different strengths and drawbacks, it is important that you provide decision makers with both perspectives.

In monetizing health benefits, a WTP measure is the conceptually appropriate measure as compared to other alternatives (e.g., cost of illness or lifetime earnings), in part because it attempts to capture pain and suffering and other quality-of-life effects. Using the WTP measure for health and safety allows you to directly compare your results to the other benefits and costs in your analysis, which will typically be based on WTP.

If well-conducted revealed-preference studies of relevant health and safety risks are available, you should consider using them in developing your monetary estimates. If appropriate revealed-preference data are not available, you should use valid and relevant data from stated-preference studies. You will need to use your professional judgment when you are faced with limited information on revealed preference studies and substantial information based on stated preference studies.

A key advantage of stated-preference and health-utility methods compared to revealed preference methods is that they can be tailored to address the ranges of probabilities, types of health risks and specific populations affected by your rule. In many rulemakings there will be no relevant information from revealed-preference studies. In this situation you should consider commissioning a stated-preference study or using values from published stated-preference studies. For the reasons discussed previously, you should be cautious about using values from stated-preference studies and describe in the analysis the drawbacks of this approach.

a. Nonfatal Health and Safety Risks

With regard to nonfatal health and safety risks, there is enormous diversity in the nature and severity of impaired health states. A traumatic injury that can be treated effectively in the emergency room without hospitalization or long-term care is different from a traumatic injury resulting in paraplegia. Severity differences are also important in evaluation of chronic diseases. A severe bout of bronchitis, though perhaps less frequent, is far more painful and debilitating than the more frequent bouts of mild bronchitis. The duration of an impaired health state, which can range from a day or two to several years or even a lifetime (e.g., birth defects inducing mental retardation), need to be considered carefully. Information on both the severity and

duration of an impaired health state is necessary before the task of monetization can be performed.

When monetizing nonfatal health effects, it is important to consider two components: (1) the private demand for prevention of the nonfatal health effect, to be represented by the preferences of the target population at risk, and (2) the net financial externalities associated with poor health such as net changes in public medical costs and any net changes in economic production that are not experienced by the target population. Revealed-preference or stated-preference studies are necessary to estimate the private demand; health economics data from published sources can typically be used to estimate the financial externalities caused by changes in health status.

If you use literature values to monetize nonfatal health and safety risks, it is important to make sure that the values you have selected are appropriate for the severity and duration of health effects to be addressed by your rule.

If data are not available to support monetization, you might consider an alternative approach that makes use of health-utility studies. Although the economics literature on the monetary valuation of impaired health states is growing, there is a much larger clinical literature on how patients, providers and community residents value diverse health states. This literature typically measures health utilities based on the standard gamble, the time tradeoff or the rating scale methods. This health utility information may be combined with known monetary values for well-defined health states to estimate monetary values for a wide range of health states of different severity and duration. If you use this approach, you should be careful to acknowledge your assumptions and the limitations of your estimates.

b. Fatality Risks

Since agencies often design health and safety regulation to reduce risks to life, evaluation of these benefits can be the key part of the analysis. A good analysis must present these benefits clearly and show their importance. Agencies may choose to monetize these benefits. The willingness-to-pay approach is the best methodology to use if reductions in fatality risk are monetized.

Some describe the monetized value of small changes in fatality risk as the "value of statistical life" (VSL) or, less precisely, the "value of a life." The latter phrase can be misleading because it suggests erroneously that the monetization exercise tries to place a "value" on individual lives. You should make clear that these terms refer to the measurement of willingness to pay for reductions in only small risks of premature death. They have no application to an identifiable individual or to very large reductions in individual risks. They do not suggest that any individual's life can be expressed in monetary terms. Their sole purpose is to help describe better the likely benefits of a regulatory action.

Confusion about the term "statistical life" is also widespread. This term refers to the sum of risk reductions expected in a population. For example, if the annual risk of death is reduced by one in a million for

each of two million people, that is said to represent two "statistical lives" extended per year (2 million people x 1/1,000,000 = 2). If the annual risk of death is reduced by one in 10 million for each of 20 million people, that also represents two statistical lives extended.

The adoption of a value for the projected reduction in the risk of premature mortality is the subject of continuing discussion within the economic and public policy analysis community. A considerable body of academic literature is available on this subject. This literature involves either explicit or implicit valuation of fatality risks, and generally involves the use of estimates of VSL from studies on wage compensation for occupational hazards (which generally are in the range of 10-4 annually), on consumer product purchase and use decisions, or from an emerging literature using stated preference approaches. A substantial majority of the resulting estimates of VSL vary from roughly $1 million to $10 million per statistical life.[17]

There is a continuing debate within the economic and public policy analysis community on the merits of using a single VSL for all situations versus adjusting the VSL estimates to reflect the specific rule context. A variety of factors have been identified, including whether the mortality risk involves sudden death, the fear of cancer, and the extent to which the risk is voluntarily incurred.[18] The consensus of EPA's recent Science Advisory Board (SAB) review of this issue was that the available literature does not support adjustments of VSL for most of these factors. The panel did conclude that it was appropriate to adjust VSL to reflect changes in income and any time lag in the occurrence of adverse health effects.

The age of the affected population has also been identified as an important factor in the theoretical literature. However, the empirical evidence on age and VSL is mixed. In light of the continuing questions over the effect of age on VSL estimates, you should not use an age-adjustment factor in an analysis using VSL estimates.[19]

Another way that has been used to express reductions in fatality risks is to use the life expectancy method, the "value of statistical life-years (VSLY) extended." If a regulation protects individuals whose average remaining life expectancy is 40 years, a risk reduction of one fatality is expressed as "40 life-years extended." Those who favor this alternative approach emphasize that the value of a statistical life is not a single number relevant for all situations. In particular, when there are significant differences between the effect on life expectancy for the population affected by a particular health risk and the populations studied in the labor market studies, they prefer to adopt a VSLY approach to reflect those differences. You should consider providing estimates of both VSL and VSLY, while recognizing the developing state of knowledge in this area.

Longevity may be only one of a number of relevant considerations pertaining to the rule. You should keep in mind that regulations with greater numbers of life-years extended are not necessarily better than regulations with fewer numbers of life-years extended. In any event, when you present estimates based on the VSLY method, you should adopt a larger VSLY estimate for senior citizens because senior citizens face larger overall health risks from all causes and they may have

accumulated savings to spend on their health and safety.[20]
The valuation of fatality risk reduction is an evolving area in both results and methodology. Hence, you should utilize valuation methods that you consider appropriate for the regulatory circumstances. Since the literature-based VSL estimates may not be entirely appropriate for the risk being evaluated (e.g., the use of occupational risk premia to value reductions in risks from environmental hazards), you should explain your selection of estimates and any adjustments of the estimates to reflect the nature of the risk being evaluated. You should present estimates based on alternative approaches, and if you monetize mortality risk reduction, you should do so on a consistent basis to the extent feasible. You should clearly indicate the methodology used and document your choice of a particular methodology. You should explain any significant deviations from the prevailing state of knowledge. If you use different methodologies in different rules, you should clearly disclose the fact and explain your choices.

c. Valuation of Reductions in Health and Safety Risks to Children

The valuation of health outcomes for children and infants poses special challenges. It is rarely feasible to measure a child's willingness to pay for health improvement and an adult's concern for his or her own health is not necessarily relevant to valuation of child health. For example, the wage premiums demanded by workers to accept hazardous jobs are not readily transferred to rules that accomplish health gains for children.
There are a few studies that examine parental willingness to pay to invest in health and safety for their children. Some of these studies suggest that parents may value children’s health more strongly than their own health. Although this parental perspective is a promising research strategy, it may need to be expanded to include a societal interest in child health and safety.
Where the primary objective of a rule is to reduce the risk of injury, disease or mortality among children, you should conduct a cost-effectiveness analysis of the rule. You may also develop a benefit-cost analysis to the extent that valid monetary values can be assigned to the primary expected health outcomes. For rules where health gains are expected among both children and adults and you decide to perform a benefit-cost analysis, the monetary values for children should be at least as large as the values for adults (for the same probabilities and outcomes) unless there is specific and compelling evidence to suggest otherwise.[21]

Discount Rates

Benefits and costs do not always take place in the same time period. When they do not, it is incorrect simply to add all of the expected net benefits or costs without taking account of when the actually occur. If benefits or costs are delayed or otherwise separated in time from each other, the difference in timing should be reflected in your analysis.

As a first step, you should present the annual time stream of benefits and costs expected to result from the rule, clearly identifying when the benefits and costs are expected to occur. The beginning point for your stream of estimates should be the year in which the final rule will begin to have effects, even if that is expected to be some time in the future. The ending point should be far enough in the future to encompass all the significant benefits and costs likely to result from the rule.

In presenting the stream of benefits and costs, it is important to measure them in constant dollars to avoid the misleading effects of inflation in your estimates. If the benefits and costs are initially measured in prices reflecting expected future inflation, you can convert them to constant dollars by dividing through by an appropriate inflation index, one that corresponds to the inflation rate underlying the initial estimates of benefits or costs.

1. The Rationale for Discounting

Once these preliminaries are out of the way, you can begin to adjust your estimates for differences in timing. (This is a separate calculation from the adjustment needed to remove the effects of future inflation.) Benefits or costs that occur sooner are generally more valuable. The main rationales for the discounting of future impacts are:

(a) Resources that are invested will normally earn a positive return, so current consumption is more expensive than future consumption, since you are giving up that expected return on investment when you consume today.

(b) Postponed benefits also have a cost because people generally prefer present to future consumption. They are said to have positive time preference.

(c) Also, if consumption continues to increase over time, as it has for most of U.S. history, an increment of consumption will be less valuable in the future than it would be today, because the principle of diminishing marginal utility implies that as total consumption increases, the value of a marginal unit of

consumption tends to decline.

There is wide agreement with point (a). Capital investment is productive, but that point is not sufficient by itself to explain positive interest rates and observed saving behavior. To understand these phenomena, points (b) and (c) are also necessary. If people are really indifferent between consumption now and later, then they should be willing to forgo current consumption in order to consume an equal or slightly greater amount in the future. That would cause saving rates and investment to rise until interest rates were driven to zero and capital was no longer productive. As long as we observe positive interest rates and saving rates below 100 percent, people must be placing a higher value on current consumption than on future consumption.

To reflect this preference, a discount factor should be used to adjust the estimated benefits and costs for differences in timing. The further in the future the benefits and costs are expected to occur, the more they should be discounted. The discount factor can be calculated given a discount rate. The formula is 1/ (1+ the discount rate)t where "t" measures the number of years in the future that the benefits or costs are expected to occur. Benefits or costs that have been adjusted in this way are called "discounted present values" or simply Apresent values". When, and only when, the estimated benefits and costs have been discounted, they can be added to determine the overall value of net benefits.

2. Real Discount Rates of 3 Percent and 7 Percent

OMB's basic guidance on the discount rate is provided in OMB Circular A-94 (http://www.whitehouse.gov/omb/circulars/index.html). This Circular points out that the analytically preferred method of handling temporal differences between benefits and costs is to adjust all the benefits and costs to reflect their value in equivalent units of consumption and to discount them at the rate consumers and savers would normally use in discounting future consumption benefits. This is sometimes called the "shadow price" approach to discounting because doing such calculations requires you to value benefits and costs using shadow prices, especially for capital goods, to correct for market distortions. These shadow prices are not well established for the United States. Furthermore, the distribution of impacts from regulations on capital and consumption are not always well known. Consequently, any agency that wishes to tackle this challenging analytical task should check with OMB before proceeding.

As a default position, OMB Circular A-94 states that a real discount rate of 7 percent should be used as a base-case for regulatory analysis. The 7 percent rate is an estimate of the average before-tax rate of return to private capital in the U.S. economy. It is a broad measure that reflects the returns to real estate and small business capital as well as corporate capital. It approximates the opportunity cost of capital, and it is the appropriate discount rate whenever the main effect of a regulation is to displace or alter the use of capital in

the private sector. OMB revised Circular A-94 in 1992 after extensive internal review and public comment. In a recent analysis, OMB found that the average rate of return to capital remains near the 7 percent rate estimated in 1992. Circular A-94 also recommends using other discount rates to show the sensitivity of the estimates to the discount rate assumption.

Economic distortions, including taxes on capital, create a divergence between the rate of return that savers earn and the private rate of return to capital. This divergence persists despite the tendency for capital to flow to where it can earn the highest rate of return. Although market forces will push after-tax rates of return in different sectors of the economy toward equality, that process will not equate pre-tax rates of return when there are differences in the tax treatment of investment. Corporate capital, in particular, pays an additional layer of taxation, the corporate income tax, which requires it to earn a higher pre-tax rate of return in order to provide investors with similar after-tax rates of return compared with non-corporate investments. The pre-tax rates of return better measure society's gains from investment. Since the rates of return on capital are higher in some sectors of the economy than others, the government needs to be sensitive to possible impacts of regulatory policy on capital allocation. The effects of regulation do not always fall exclusively or primarily on the allocation of capital. When regulation primarily and directly affects private consumption (e.g., through higher consumer prices for goods and services), a lower discount rate is appropriate. The alternative most often used is sometimes called the "social rate of time preference." This simply means the rate at which "society" discounts future consumption flows to their present value. If we take the rate that the average saver uses to discount future consumption as our measure of the social rate of time preference, then the real rate of return on long-term government debt may provide a fair approximation. Over the last thirty years, this rate has averaged around 3 percent in real terms on a pre-tax basis. For example, the yield on 10-year Treasury notes has averaged 8.1 percent since 1973 while the average annual rate of change in the CPI over this period has been 5.0 percent, implying a real 10-year rate of 3.1 percent. For regulatory analysis, you should provide estimates of net benefits using both 3 percent and 7 percent. An example of this approach is EPA's analysis of its 1998 rule setting both effluent limits for wastewater discharges and air toxic emission limits for pulp and paper mills. In this analysis, EPA developed its present-value estimates using real discount rates of 3 and 7 percent applied to benefit and cost streams that extended forward for 30 years. You should present a similar analysis in your own work.

In some instances, if there is reason to expect that the regulation will cause resources to be reallocated away from private investment in the corporate sector, then the opportunity cost may lie outside the range of 3 to 7 percent. For example, the average real rate of return on corporate capital in the United States was approximately 10 percent in the 1990s, returning to the same level observed in the 1950s and 1960s. If you are uncertain about the nature of the opportunity cost,

then you should present benefit and cost estimates using a higher discount rate as a further sensitivity analysis as well as using the 3 and 7 percent rates.

3. Time Preference for Health-Related Benefits and Costs

When future benefits or costs are health-related, some have questioned whether discounting is appropriate, since the rationale for discounting money may not appear to apply to health. It is true that lives saved today cannot be invested in a bank to save more lives in the future. But the resources that would have been used to save those lives can be invested to earn a higher payoff in future lives saved. People have been observed to prefer health gains that occur immediately to identical health gains that occur in the future. Also, if future health gains are not discounted while future costs are, then the following perverse result occurs: an attractive investment today in future health improvement can always be made more attractive by delaying the investment. For such reasons, there is a professional consensus that future health effects, including both benefits and costs, should be discounted at the same rate. This consensus applies to both BCA and CEA.

A common challenge in health-related analysis is to quantify the time lag between when a rule takes effect and when the resulting physical improvements in health status will be observed in the target population. In such situations, you must carefully consider the timing of health benefits before performing present-value calculations. It is not reasonable to assume that all of the benefits of reducing chronic diseases such as cancer and cardiovascular disease will occur immediately when the rule takes effect. For rules addressing traumatic injury, this lag period may be short. For chronic diseases it may take years or even decades for a rule to induce its full beneficial effects in the target population.

When a delay period between exposure to a toxin and increased probability of disease is likely (a so-called latency period), a lag between exposure reduction and reduced probability of disease is also likely. This latter period has sometimes been referred to as a "cessation lag," and it may or may not be of the same duration as the latency period. As a general matter, cessation lags will only apply to populations with at least some high-level exposure (e.g., before the rule takes effect). For populations with no such prior exposure, such as those born after the rule takes effect, only the latency period will be relevant.

Ideally, your exposure-risk model would allow calculation of reduced risk for each year following exposure cessation, accounting for total cumulative exposure and age at the time of exposure reduction. The present-value benefits estimate could then reflect an appropriate discount factor for each year's risk reduction. Recent analyses of the cancer benefits stemming from reduction in public exposure to radon in drinking water have adopted this approach. They were supported by formal risk-assessment models that allowed estimates of the timing of lung cancer incidence and mortality to vary in response to different

radon exposure levels.[22]
In many cases, you will not have the benefit of such detailed risk assessment modeling. You will need to use your professional judgment as to the average cessation lag for the chronic diseases affected by your rule. In situations where information exists on latency but not on cessation lags, it may be reasonable to use latency as a proxy for the cessation lag, unless there is reason to believe that the two are different. When the average lag time between exposures and disease is unknown, a range of plausible alternative values for the time lag should be used in your analysis.

4. Intergenerational Discounting

Special ethical considerations arise when comparing benefits and costs across generations. Although most people demonstrate time preference in their own consumption behavior, it may not be appropriate for society to demonstrate a similar preference when deciding between the well-being of current and future generations. Future citizens who are affected by such choices cannot take part in making them, and today's society must act with some consideration of their interest.
One way to do this would be to follow the same discounting techniques described above and supplement the analysis with an explicit discussion of the intergenerational concerns (how future generations will be affected by the regulatory decision). Policymakers would be provided with this additional information without changing the general approach to discounting.
Using the same discount rate across generations has the advantage of preventing time-inconsistency problems. For example, if one uses a lower discount rate for future generations, then the evaluation of a rule that has short-term costs and long-term benefits would become more favorable merely by waiting a year to do the analysis. Further, using the same discount rate across generations is attractive from an ethical standpoint. If one expects future generations to be better off, then giving them the advantage of a lower discount rate would in effect transfer resources from poorer people today to richer people tomorrow.
Some believe, however, that it is ethically impermissible to discount the utility of future generations. That is, government should treat all generations equally. Even under this approach, it would still be correct to discount future costs and consumption benefits generally (perhaps at a lower rate than for intragenerational analysis), due to the expectation that future generations will be wealthier and thus will value a marginal dollar of benefits or costs by less than those alive today. Therefore, it is appropriate to discount future benefits and costs relative to current benefits and costs, even if the welfare of future generations is not being discounted. Estimates of the appropriate discount rate appropriate in this case, from the 1990s, ranged from 1 to 3 percent per annum.[23]

A second reason for discounting the benefits and costs accruing to

future generations at a lower rate is increased uncertainty about the appropriate value of the discount rate, the longer the horizon for the analysis. Private market rates provide a reliable reference for determining how society values time within a generation, but for extremely long time periods no comparable private rates exist. As explained by Martin Weitzman[24], in the limit for the deep future, the properly averaged certainty-equivalent discount factor (i.e., $1/[1+r]^t$) corresponds to the minimum discount rate having any substantial positive probability. From today's perspective, the only relevant limiting scenario is the one with the lowest discount rate B all of the other states at the far-distant time are relatively much less important because their expected present value is so severely reduced by the power of compounding at a higher rate.
If your rule will have important intergenerational benefits or costs you might consider a further sensitivity analysis using a lower but positive discount rate in addition to calculating net benefits using discount rates of 3 and 7 percent.

5. Time Preference for Non-Monetized Benefits and Costs

Differences in timing should be considered even for benefits and costs that are not expressed in monetary units, including health benefits. The timing differences can be handled through discounting. EPA estimated cost-effectiveness in its 1998 rule, "Control of Emissions from Nonroad Diesel Engines," by discounting both the monetary costs and the non-monetized emission reduction benefits over the expected useful life of the engines at the 7 percent real rate recommended in OMB Circular A-94.
Alternatively, it may be possible in some cases to avoid discounting non-monetized benefits. If the expected flow of benefits begins as soon as the cost is incurred and is expected to be constant over time, then annualizing the cost stream is sufficient, and further discounting of benefits is unnecessary. Such an analysis might produce an estimate of the annualized cost per ton of reduced emissions of a pollutant.

6. The Internal Rate of Return

The internal rate of return is the discount rate that sets the net present value of the discounted benefits and costs equal to zero. The internal rate of return does not generally provide an acceptable decision criterion, and regulations with the highest internal rate of return are not necessarily the most beneficial. Nevertheless, it does provide useful information and for many it will offer a meaningful indication of regulation's impact. You should consider including the internal rate of return implied by your regulatory analysis along with other information about discounted net present values.

Other Key Considerations

1. Other Benefit and Cost Considerations

You should include these effects in your analysis and provide estimates of their monetary values when they are significant:

- Private-sector compliance costs and savings;
- Government administrative costs and savings;
- Gains or losses in consumers' or producers' surpluses;
- Discomfort or inconvenience costs and benefits; and
- Gains or losses of time in work, leisure and/or commuting/travel settings.

Estimates of benefits and costs should be based on credible changes in technology over time. For example, retrospective studies may provide evidence that "learning" will likely reduce the cost of regulation in future years. The weight you give to a study of past rates of cost savings resulting from innovation (including "learning curve" effects) should depend on both its timeliness and direct relevance to the processes affected by the regulatory alternative under consideration. In addition, you should take into account cost-saving innovations that result from a shift to regulatory performance standards and incentive-based policies. On the other hand, significant costs may result from a slowing in the rate of innovation or of adoption of new technology due to delays in the regulatory approval process or the setting of more stringent standards for new facilities than existing ones. In some cases agencies are limited under statute to consider only technologies that have been demonstrated to be feasible. In these situations, it may be useful to estimate costs and cost savings assuming a wider range of technical possibilities.

When characterizing technology changes over time, you should assess the likely technology changes that would have occurred in the absence of the regulatory action (technology baseline). Technologies change over time in both reasonably functioning markets and imperfect markets. If you assume that technology will remain unchanged in the absence of regulation when technology changes are likely, then your analysis will over-state both the benefits and costs attributable to the regulation.

Occasionally, cost savings or other forms of benefits accrue to parties affected by a rule who also bear its costs. For example, a requirement that engine manufacturers reduce emissions from engines may lead to technologies that improve fuel economy. These fuel savings will normally accrue to the engine purchasers, who also bear the costs of the technologies. There is no apparent market failure with regard to the market value of fuel saved because one would expect that consumers would be willing to pay for increased fuel economy that exceeded the cost of providing it. When these cost savings are substantial, and particularly when you estimate them to be greater than the cost associated with achieving them, you should examine and discuss why market forces would not accomplish these gains in the absence of regulation. As a general matter, any direct costs that are averted as a result of a regulatory action should be monetized

wherever possible and either added to the benefits or subtracted from the costs of that alternative.

2. The Difference between Costs (or Benefits) and Transfer Payments

Distinguishing between real costs and transfer payments is an important, but sometimes difficult, problem in cost estimation. Benefit and cost estimates should reflect real resource use. Transfer payments are monetary payments from one group to another that do not affect total resources available to society. A regulation that restricts the supply of a good, causing its price to rise, produces a transfer from buyers to sellers. The net reduction in the total surplus (consumer plus producer) is a real cost to society, but the transfer from buyers to sellers resulting from a higher price is not a real cost since the net reduction automatically accounts for the transfer from buyers to sellers. However, transfers from the United States to other nations *should* be included as costs, and transfers from other nations to the United States as benefits, as long as the analysis is conducted from the United States perspective.
You should not include transfers in the estimates of the benefits and costs of a regulation. Instead, address them in a separate discussion of the regulation's distributional effects. Examples of transfer payments include the following:

- Scarcity rents and monopoly profits
- Insurance payments
- Indirect taxes and subsidies

Treatment of Uncertainty

The precise consequences (benefits and costs) of regulatory options are not always known for certain, but the probability of their occurrence can often be developed. The important uncertainties connected with your regulatory decisions need to be analyzed and presented as part of the overall regulatory analysis. You should begin your analysis of uncertainty at the earliest possible stage in developing your analysis. You should consider both the statistical variability of key elements underlying the estimates of benefits and costs (for example, the expected change in the distribution of automobile accidents that might result from a change in automobile safety standards) and the incomplete knowledge about the relevant relationships (for example, the uncertain knowledge of how some economic activities might affect future climate change).[25] By assessing the sources of uncertainty and the way in which benefit and cost estimates may be affected under plausible assumptions, you can shape your analysis to inform decision makers and the public about the effects and the uncertainties of alternative regulatory actions.
The treatment of uncertainty must be guided by the same principles of full disclosure and transparency that apply to other elements of your regulatory analysis. Your analysis should be credible, objective,

realistic, and scientifically balanced.[26] Any data and models that you use to analyze uncertainty should be fully identified. You should also discuss the quality of the available data used. Inferences and assumptions used in your analysis should be identified, and your analytical choices should be explicitly evaluated and adequately justified. In your presentation, you should delineate the strengths of your analysis along with any uncertainties about its conclusions. Your presentation should also explain how your analytical choices have affected your results.

In some cases, the level of scientific uncertainty may be so large that you can only present discrete alternative scenarios without assessing the relative likelihood of each scenario quantitatively. For instance, in assessing the potential outcomes of an environmental effect, there may be a limited number of scientific studies with strongly divergent results. In such cases, you might present results from a range of plausible scenarios, together with any available information that might help in qualitatively determining which scenario is most likely to occur. When uncertainty has significant effects on the final conclusion about net benefits, your agency should consider additional research prior to rulemaking. The costs of being wrong may outweigh the benefits of a faster decision. This is true especially for cases with irreversible or large upfront investments. If your agency decides to proceed with rulemaking, you should explain why the costs of developing additional information—including any harm from delay in public protection—exceed the value of that information.

For example, when the uncertainty is due to a lack of data, you might consider deferring the decision, as an explicit regulatory alternative, pending further study to obtain sufficient data. Delaying a decision will also have costs, as will further efforts at data gathering and analysis. You will need to weigh the benefits of delay against these costs in making your decision. Formal tools for assessing the value of additional information are now well developed in the applied decision sciences and can be used to help resolve this type of complex regulatory question.

"Real options" methods have also formalized the valuation of the added flexibility inherent in delaying a decision. As long as taking time will lower uncertainty, either passively or actively through an investment in information gathering, and some costs are irreversible, such as the potential costs of a sunk investment, a benefit can be assigned to the option to delay a decision. That benefit should be considered a cost of taking immediate action versus the alternative of delaying that action pending more information. However, the burdens of delay—including any harm to public health, safety, and the environment—need to be analyzed carefully.

1. Quantitative Analysis of Uncertainty

Examples of quantitative analysis, broadly defined, would include formal estimates of the probabilities of environmental damage to soil or water, the possible loss of habitat, or risks to endangered species as well as probabilities of harm to human health and safety. There are

also uncertainties associated with estimates of economic benefits and costs, such as the cost savings associated with increased energy efficiency. Thus, your analysis should include two fundamental components: a quantitative analysis characterizing the probabilities of the relevant outcomes and an assignment of economic value to the projected outcomes. It is essential that both parts be conceptually consistent. In particular, the quantitative analysis should be conducted in a way that permits it to be applied within a more general analytical framework, such as benefit-cost analysis. Similarly, the general framework needs to be flexible enough to incorporate the quantitative analysis without oversimplifying the results. For example, you should address explicitly the implications for benefits and costs of any probability distributions developed in your analysis.

As with other elements of regulatory analysis, you will need to balance thoroughness with the practical limits on your analytical capabilities. Your analysis does not have to be exhaustive, nor is it necessary to evaluate each alternative at every step. Attention should be devoted to first resolving or studying the uncertainties that have the largest potential effect on decision making. Many times these will be the largest sources of uncertainties. In the absence of adequate data, you will need to make assumptions. These should be clearly identified and consistent with the relevant science. Your analysis should provide sufficient information for decision makers to grasp the degree of scientific uncertainty and the robustness of estimated probabilities, benefits, and costs to changes in key assumptions.

For major rules involving annual economic effects of $1 billion or more, you should present a formal quantitative analysis of the relevant uncertainties about benefits and costs. In other words, you should try to provide some estimate of the probability distribution of regulatory benefits and costs. In summarizing the probability distributions, you should provide some estimates of the central tendency (e.g., mean and median) along with any other information you think will be useful such as ranges, variances, specified low-end and high-end percentile estimates, and other characteristics of the distribution.

Your estimates cannot be more precise than their most uncertain component. Thus, your analysis should report estimates in a way that reflects the degree of uncertainty and not create a false sense of precision. Worst-case or conservative analyses are not usually adequate because they do not convey the complete probability distribution of outcomes, and they do not permit calculation of an expected value of net benefits. In many health and safety rules, economists conducting benefit-cost analyses must rely on formal risk assessments that address a variety of risk management questions such as the baseline risk for the affected population, the safe level of exposure or, the amount of risk to be reduced by various interventions. Because the answers to some of these questions are directly used in benefits analyses, the risk assessment methodology must allow for the determination of expected benefits in order to be comparable to expected costs. This means that conservative assumptions and defaults (whether motivated by science policy or by

precautionary instincts), will be incompatible with benefit analyses as they will result in benefit estimates that exceed the expected value. Whenever it is possible to characterize quantitatively the probability distributions, some estimates of expected value (e.g., mean and median) must be provided in addition to ranges, variances, specified low-end and high-end percentile estimates, and other characteristics of the distribution.

Whenever possible, you should use appropriate statistical techniques to determine a probability distribution of the relevant outcomes. For rules that exceed the $1 billion annual threshold, a formal quantitative analysis of uncertainty is required. For rules with annual benefits and/or costs in the range from 100 million to $1 billion, you should seek to use more rigorous approaches with higher consequence rules. This is especially the case where net benefits are close to zero. More rigorous uncertainty analysis may not be necessary for rules in this category if simpler techniques are sufficient to show robustness. You may consider the following analytical approaches that entail increasing levels of complexity:

- Disclose qualitatively the main uncertainties in each important input to the calculation of benefits and costs. These disclosures should address the uncertainties in the data as well as in the analytical results. However, major rules above the $1 billion annual threshold require a formal treatment.
- Use a numerical sensitivity analysis to examine how the results of your analysis vary with plausible changes in assumptions, choices of input data, and alternative analytical approaches. Sensitivity analysis is especially valuable when the information is lacking to carry out a formal probabilistic simulation. Sensitivity analysis can be used to find "switch points" -- critical parameter values at which estimated net benefits change sign or the low cost alternative switches. Sensitivity analysis usually proceeds by changing one variable or assumption at a time, but it can also be done by varying a combination of variables simultaneously to learn more about the robustness of your results to widespread changes. Again, however, major rules above the $1 billion annual threshold require a formal treatment.
- Apply a formal probabilistic analysis of the relevant uncertainties B possibly using simulation models and/or expert judgment as revealed, for example, through Delphi methods.[28] Such a formal analytical approach is appropriate for complex rules where there are large, multiple uncertainties whose analysis raises technical challenges, or where the effects cascade; it is required for rules that exceed the $1 billion annual threshold. For example, in the analysis of regulations addressing air pollution, there is uncertainty about the effects of the rule on future emissions, uncertainty about how the change in emissions will affect air quality, uncertainty about how changes in air quality will affect health, and finally uncertainty about the economic and social value of the change

in health outcomes. In formal probabilistic assessments, expert solicitation is a useful way to fill key gaps in your ability to assess uncertainty.[29] In general, experts can be used to quantify the probability distributions of key parameters and relationships. These solicitations, combined with other sources of data, can be combined in Monte Carlo simulations to derive a probability distribution of benefits and costs. You should pay attention to correlated inputs. Often times, the standard defaults in Monte Carlo and other similar simulation packages assume independence across distributions. Failing to correctly account for correlated distributions of inputs can cause the resultant output uncertainty intervals to be too large, although in many cases the overall effect is ambiguous. You should make a special effort to portray the probabilistic results—in graphs and/or tables—clearly and meaningfully.

New methods may become available in the future. This document is not intended to discourage or inhibit their use, but rather to encourage and stimulate their development.

2. Economic Values of Uncertain Outcomes

In developing benefit and cost estimates, you may find that there are probability distributions of values as well for each of the outcomes. Where this is the case, you will need to combine these probability distributions to provide estimated benefits and costs.
Where there is a distribution of outcomes, you will often find it useful to emphasize summary statistics or figures that can be readily understood and compared to achieve the broadest public understanding of your findings. It is a common practice to compare the "best estimates" of both benefits and costs with those of competing alternatives. These "best estimates" are usually the average or the expected value of benefits and costs. Emphasis on these expected values is appropriate as long as society is "risk neutral" with respect to the regulatory alternatives. While this may not always be the case, you should in general assume "risk neutrality" in your analysis. If you adopt a different assumption on risk preference, you should explain your reasons for doing so.

3. Alternative Assumptions

If benefit or cost estimates depend heavily on certain assumptions, you should make those assumptions explicit and carry out sensitivity analyses using plausible alternative assumptions. If the value of net benefits changes from positive to negative (or vice versa) or if the relative ranking of regulatory options changes with alternative plausible assumptions, you should conduct further analysis to determine which of the alternative assumptions is more appropriate. Because different estimation methods may have hidden assumptions, you should analyze estimation methods carefully to make any hidden

assumptions explicit.

F. Specialized Analytical Requirements

In preparing analytical support for your rulemaking, you should be aware that there are a number of analytic requirements imposed by law and Executive Order. In addition to the regulatory analysis requirements of Executive Order 12866, you should also consider whether your rule will need specialized analysis of any of the following issues.

Impact on Small Businesses and Other Small Entities

Under the Regulatory Flexibility Act (5 U.S.C. chapter 6), agencies must prepare a proposed and final "regulatory flexibility analysis" (RFA) if the rulemaking could "have a significant impact on a substantial number of small entities." You should consider posting your RFA on the internet so the public can review your findings.
Your agency should have guidelines on how to prepare an RFA and you are encouraged to consult with the Chief Counsel for Advocacy of the Small Business Administration on expectations concerning what is an adequate RFA. Executive Order 13272 (67 FR 53461, August 16, 2002) requires you to notify the Chief Counsel for Advocacy of any draft rules that might have a significant economic impact on a substantial number of small entities. Executive Order 13272 also directs agencies to give every appropriate consideration to any comments provided by the Advocacy Office. Under SBREFA, EPA and OSHA are required to consult with small business prior to developing a proposed rule that would have a significant effect on small businesses. OMB encourages other agencies to do so as well.

Analysis of Unfunded Mandates

Under the Unfunded Mandates Act (2 U.S.C. 1532), you must prepare a written statement about benefits and costs prior to issuing a proposed or final rule (for which your agency published a proposed rule) that may result in aggregate expenditure by State, local, and tribal governments, or by the private sector, of $100,000,000 or more in any one year (adjusted annually for inflation). Your analytical requirements under Executive Order 12866 are similar to the analytical requirements under this Act, and thus the same analysis may permit you to comply with both analytical requirements.

Information Collection, Paperwork, and Recordkeeping Burdens

Under the Paperwork Reduction Act (44 U.S.C. chapter 35), you will need to consider whether your rulemaking (or other actions) will create any additional information collection, paperwork or recordkeeping burdens. These burdens are permissible only if you can

justify the practical utility of the information for the implementation of your rule. OMB approval will be required of any new requirements for a collection of information imposed on 10 or more persons and a valid OMB control number must be obtained for any covered paperwork. Your agency's CIO should be able to assist you in complying with the Paperwork Reduction Act.

Information Quality Guidelines

Under the Information Quality Law, agency guidelines, in conformance with the OMB government-wide guidelines (67 FR 8452, February 22, 2002), have established basic quality performance goals for all information disseminated by agencies, including information disseminated in support of proposed and final rules. The data and analysis that you use to support your rule must meet these agency and OMB quality standards. Your agency's CIO should be able to assist you in assessing information quality. The Statistical and Science Policy Branch of OMB's Office of Information and Regulatory Affairs can provide you assistance. This circular defines OMB's minimum quality standards for regulatory analysis.

Environmental Impact Statements

The National Environmental Policy Act (42 U.S.C. 4321-4347) and related statutes and executive orders require agencies to consider the environmental impacts of agency decisions, including rulemakings. An environmental impact statement must be prepared for "major Federal actions significantly affecting the quality of the human environment." You must complete NEPA documentation before issuing a final rule. The White House Council on Environmental Quality has issued regulations (40 C.F.R. 1500-1508) and associated guidance for implementation of NEPA, available through CEQ's website (http://www.whitehouse.gov/ceq/).

Impacts on Children

Under Executive Order 13045, "Protection of Children from Environmental Health Risks and Safety Risks," each agency must, with respect to its rules, "to the extent permitted by law and appropriate, and consistent with the agency's mission," "address disproportionate risks to children that result from environmental health risks or safety risks." For any substantive rulemaking action that "is likely to result in" an economically significant rule that concerns "an environmental health risk or safety risk that an agency has reason to believe may disproportionately affect children," the agency must provide OMB/OIRA "an evaluation of the environmental health or safety effects of the planned regulation on children," as well as "an explanation of why the planned regulation is preferable to other potentially and reasonably feasible alternatives considered by the agency."

Energy Impacts

Under Executive Order 13211 (66 FR 28355, May 22, 2001), agencies are required to prepare and submit to OMB a Statement of Energy Effects for significant energy actions, to the extent permitted by law. This Statement is to include a detailed statement of "any adverse effects on energy supply, distribution, or use (including a shortfall in supply, price increases, and increased use of foreign supplies)" for the action and reasonable alternatives and their effects. You need to publish the Statement or a summary in the related NPRM and final rule. For further guidance, see OMB Memorandum 01-27 ("Guidance on Implementing Executive Order 13211", July 13, 2001), available on OMB's website.

G. Accounting Statement

You need to provide an accounting statement with tables reporting benefit and cost estimates for each major final rule for your agency. You should use the guidance outlined above to report these estimates. We have included a suggested format for your consideration.

Categories of Benefits and Costs

To the extent feasible, you should quantify all potential incremental benefits and costs. You should report benefit and cost estimates within the following three categories: monetized quantified, but not monetized; and qualitative, but not quantified or monetized. These categories are mutually exclusive and exhaustive. Throughout the process of listing preliminary estimates of benefits and costs, agencies should avoid double-counting. This problem may arise if more than one way exists to express the same change in social welfare.

Quantifying and Monetizing Benefits and Costs

You should develop quantitative estimates and convert them to dollar amounts if possible. In many cases, quantified estimates are readily convertible, with a little effort, into dollar equivalents.

Qualitative Benefits and Costs

You should categorize or rank the qualitative effects in terms of their importance (e.g., certainty, likely magnitude, and reversibility). You should distinguish the effects that are likely to be significant enough to warrant serious consideration by decision makers from those that are likely to be minor.

Treatment of Benefits and Costs over Time

You should present undiscounted streams of benefit and cost estimates (monetized and net) for each year of the analytic time horizon. You should present annualized benefits and costs using real discount rates of 3 and 7 percent. The stream of annualized estimates should begin in the year in which the final rule will begin to have effects, even if the rule does not take effect immediately. Please report all monetized effects in 2001 dollars. You should convert dollars expressed in different years to 2001 dollars using the GDP deflator.

Treatment of Risk and Uncertainty

You should provide expected-value estimates as well as distributions about the estimates, where such information exists. When you provide only upper and lower bounds (in addition to best estimates), you should, if possible, use the 95 and 5 percent confidence bounds. Although we encourage you to develop estimates that capture the *5* of plausible outcomes for a particular alternative, detailed reporting of such distributions is not required, but should be available upon request.

The principles of full disclosure and transparency apply to the treatment of uncertainty. Where there is significant uncertainty and the resulting inferences and/or assumptions have a critical effect on the benefit and cost estimates, you should describe the benefits and costs under plausible alternative assumptions. You may add footnotes to the table as needed to provide documentation and references, or to express important warnings.

In a previous section, we identified some of the issues associated with developing estimates of the value of reductions in premature mortality risk. Based on this discussion, you should present alternative primary estimates where you use different estimates for valuing reductions in premature mortality risk.

Precision of Estimates

Reported estimates should reflect, to the extent feasible, the precision in the analysis. For example, an estimate of $220 million implies rounding to the nearest $10 million and thus a precision of +/-$5 million; similarly, an estimate of $222 million implies rounding to the nearest $1 million and thus, a precision of +/-$0.5 million.

Separate Reporting of Transfers

You should report transfers separately and avoid the misclassification of transfer payments as benefits or costs. Transfers occur when wealth or income is redistributed without any direct change in aggregate social welfare. To the extent that regulatory outputs reflect transfers rather than net welfare gains to society, you should identify them as

transfers rather than benefits or costs. You should also distinguish transfers caused by Federal budget actions -- such as those stemming from a rule affecting Social Security payments -- from those that involve transfers between non-governmental parties -- such as monopoly rents a rule may confer on a private party. You should use as many categories as necessary to describe the major redistributive effects of a regulatory action. If transfers have significant efficiency effects in addition to distributional effects, you should report them.

Effects on State, Local, and Tribal Governments, Small Business, Wages and Economic Growth

You need to identity the portions of benefits, costs, and transfers received by State, local, and tribal governments. To the extent feasible, you also should identify the effects of the rule or program on small businesses, wages, and economic growth. Note that rules with annual costs that are less than one billion dollars are likely to have a minimal effect on economic growth.

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H. Effective Date

The effective date of this Circular is January 1, 2004 for regulatory analyses received by OMB in support of proposed rules, and January 1, 2005 for regulatory analyses received by OMB in support of final rules. In other words, this Circular applies to the regulatory analyses for draft proposed rules that are formally submitted to OIRA after December 31, 2003, and for draft final rules that are formally submitted to OIRA after December 31, 2004. (However, if the draft proposed rule is subject to the Circular, then the draft final rule will also be subject to the Circular, even if it is submitted prior to January 1, 2005.) To the extent practicable, agencies should comply earlier than these effective dates. Agencies may, on a case-by-case basis, seek a waiver from OMB if these effective dates are impractical.

[1] We use the term "proposed" to refer to any regulatory actions under consideration regardless of the stage of the regulatory process.

[2] See Mishan EJ (1994), *Cost-Benefit Analysis*, fourth edition, Routledge, New York.

[3] See Coase RH (1960), *Journal of Law and Economics*, 3, 1-44.

[4] Mishan EJ (1994), *Cost-Benefit Analysis*, fourth edition, Routledge, New York.

[5] For a full discussion of CEA, see Gold, ML, Siegel, JE, Russell, LB, and Weinstein, MC (1996), *Cost Effectiveness in Health and Medicine: The Report of the Panel on Cost-Effectiveness in Health and Medicine*,

Oxford University Press, New York.

[6] Gold ML, Siegel JE, Russell LB, and Weinstein MC (1996), *Cost Effectiveness in Health and Medicine: The Report of the Panel on Cost-Effectiveness in Health and Medicine*, Oxford University Press, New York, pp. 284-285.

[7] Russell LB and Sisk JE (2000), "Modeling Age Differences in Cost Effectiveness Analysis", *International Journal of Technology Assessment in Health Care*, 16(4), 1158-1167.

[8] Pliskin JS, Shepard DS, and Weinstein MC (1980), "Utility Functions for Life Years and Health Status," *Operations Research*, 28(1), 206-224.

[9] Hammitt JK (2002), "QALYs Versus WTP," *Risk Analysis*, 22(5), pp. 985-1002.

[10] For the least stringent alternative, you should estimate the incremental benefits and costs relative to the baseline. Thus, for this alternative, the incremental effects would be the same as the corresponding totals. For each alternative that is more stringent than the least stringent alternative, you should estimate the incremental benefits and costs relative to the closest less-stringent alternative.

[11] See Hanemann WM (1991), *American Economic Review*, 81(3), 635-647.

[12] See Kahneman D, Knetsch JL, and Thaler RH (1991), "Anomalies: The Endowment Effect, Loss Aversion, and Status Quo Bias," *Journal of Economic Perspectives* 3(1), 192-206.

[13] Consumer surplus is the difference between what a consumer pays for a unit of a good and the maximum amount the consumer would be willing to pay for that unit. It is measured by the area between the price and the demand curve for that unit. Producer surplus is the difference between the amount a producer is paid for a unit of a good and the minimum amount the producer would accept to supply that unit. It is measured by the area between the price and the supply curve for that unit.

[14] See McConnell KE (1997), *Journal of Environmental Economics and Management*, 32, 22-37.

[15] See Loomis JB (1992), *Water Resources Research*, 28(3), 701-705 and Kirchoff, S, Colby, BG, and LaFrance, JT (1997), *Journal of Environmental Economics and Management*, 33, 75-93.

[16] Mishan EJ (1994), *Cost-Benefit Analysis*, fourth edition, Routledge,

New York.

[17] See Viscusi WK and Aldy JE, *Journal of Risk and Uncertainty* (forthcoming) and Mrozek JR and Taylor LO (2002), *Journal of Policy Analysis and Management*, 21(2), 253-270.

[18] Distinctions between "voluntary" and "involuntary" should be treated with care. Risks are best considered to fall within a continuum from "voluntary" to "involuntary" with very few risks at either end of this range. These terms are also related to differences in the cost of avoiding risks.

[19] Graham JD (2003), Memorandum to the President's Management Council, Benefit-Cost Methods and Lifesaving Rules. This memorandum can be found at http://www.whitehouse.gov/omb/inforeg/pmc_benefit_cost_memo.pdf

[20] Office of Information and Regulatory Affairs, OMB, Memorandum to the President's Management Council, ibid.

[21] For more information, see Dockins C., Jenkins RR, Owens N, Simon NB, and Wiggins LB (2002), *Risk Analysis*, 22(2), 335-346.

[22] Committee on Risk Assessment of Exposure to Radon in Drinking Water, Board on Radiation Effects Research, Commission on Life Sciences (1996), *Risk Assessment of Radon in Drinking Water*, National Research Council, National Academy Press, Washington, DC.

[23] Portney PR and Weyant JP, eds. (1999), *Discounting and Intergenerational Equity*, Resources for the Future, Washington, DC.

[24] Weitzman ML In Portney PR and Weyant JP, eds. (1999), *Discounting and Intergenerational Equity*, Resources for the Future, Washington, DC.

[25] In some contexts, the word "variability" is used as a synonym for statistical variation that can be described by a theoretically valid distribution function, whereas "uncertainty" refers to a more fundamental lack of knowledge. Throughout this discussion, we use the term "uncertainty" to refer to both concepts.

[26] When disseminating information, agencies should follow their own information quality guidelines, issued in conformance with the OMB government-wide guidelines (67 FR 8452, February 22, 2002).

[27] Clemen RT (1996), Making Hard Decisions: *An Introduction to Decision Analysis*, second edition, Duxbury Press, Pacific Grove.

[28] The purpose of Delphi methods is to generate suitable information

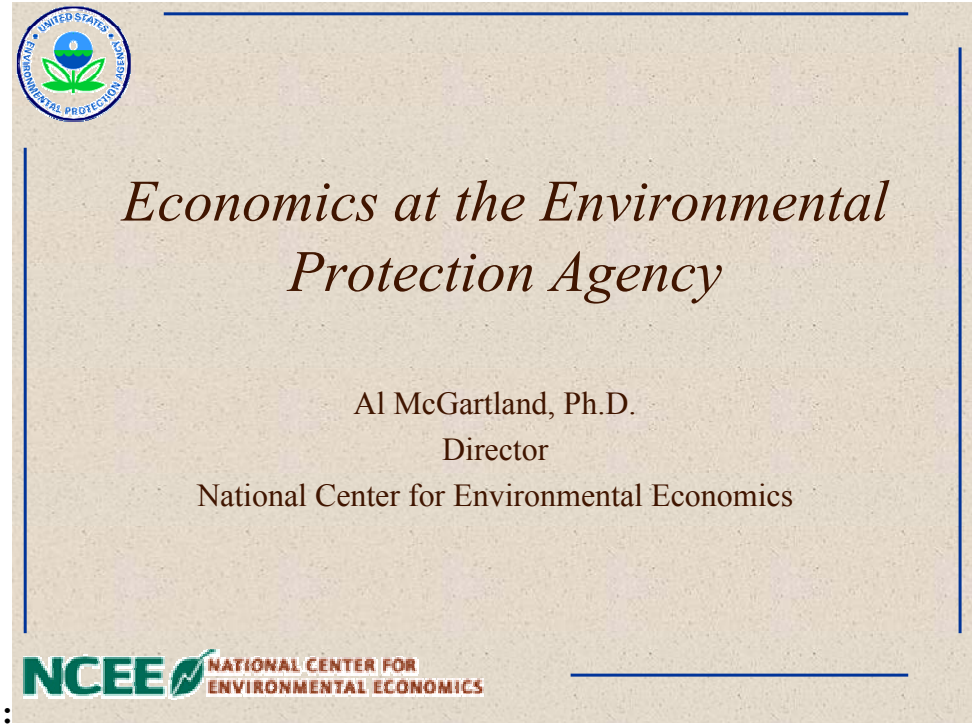
for decision making by eliciting expect judgment. The elicitation is conducted through a survey process which eliminates the interactions between experts. See Morgan MG and Henrion M (1990), *Uncertainty: A Guide to Dealing with Uncertainty in Quantitative Riskand Policy Analysis*, Cambridge University Press.

[29] Cooke RM (1991), *Experts in Uncertainty: Opinion and Subjective Probability in Science*, Oxford University Press.

[30] The Regulatory Flexibility Act (5 U.S.C. 603(c), 604).

Appendix D: Economics at the Environmental Protection Agency: Powerpoint Presentation made by Dr. Albert McGartland at the October 2003 Meeting of the Committee on Valuing the Protection of Ecological Systems and Services .

(Click on the presentation in MS Word to view the presentation. Slides include: Analysis Allowable Under Environmental Statutes; high points of Executive Order 12866 (as amended by Executive Order 13258); EPA's Rule Development Process; Components of an Economic Analysis; Benefit categories as described in EPA 2000. Guidelines for Preparing Economic Analyses. Washington, D.C.: Office of the Administrator. EPA 240-R-00-003; and some general slides on benefit-cost analysis)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